INDIA RUBBER AND GUTTA PERCHA:

BEING

A COMPILATION OF ALL THE AVAILABLE INFORMATION

RESPECTING THE TREES

YIELDING THESE ARTICLES OF COMMERCE AND THEIR

CULTIVATION;

With Notes on the Preparation and Manufacture of RUBBER AND GUTTA PERCHA.

[SECOND EDITION—REVISED AND ENLARGED.]

COMPILED AND PUBLISHED BY
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INTRODUCTION.

To meet the request frequently sent to us for information in a pamphlet or book form respecting trees yielding India-rubber, their cultivation, uses, and value in commerce, we have collected and printed the following pages. It is not impossible at this stage of the enterprise in Ceylon to do much by way of comparing the statements of the diffeɹent writers with local experience. As a preliminary to the "Ceylon Rubber Planters' Manual" of the future, we have republished what is said about India-rubber by every authority or compiler within our reach; and, although a great deal of the matter may be found repeated more than once, we have thought it best in the first instance to give the extracts *verbatim*, so that the amount of authority attaching to each statement and opinion may be fully and readily seen.

Among the works from which we have extracted are the following:—

The "Encyclopædia Britannica," latest edition.
Knight's "English Cyclopædia," vol. 3.
Lindley's "Vegetable Kingdom."
Schleiden's Lectures—"The Plant."
Clements Markham's "Peruvian Bark."
Dr. Trimen's "Notes on Some Trees yielding India-rubber."
"Journal of the Society of Arts."
Dr. G. W. Strettell's "Notes on Caoutchouc."
Report on the Caoutchouc of Commerce by James Collins, F.B.S., Edin.
Mr. Brandis on "Rubber in India."
Mr. Thomas Christy on "India-rubber."
Report on the Investigation and Collection of Plants and Seeds of the "India-rubber Trees of Para and Ceara and Balsam of Copaiba," by Robert Cross.
Extract from the Report of the Royal Botanical Gardens, Calcutta, for the year 1880-81.
From the "Ceylon Observer."
Do. "Tropical Agriculturist," (our Monthly Periodical.)
Mr. A. Scott-Blacklaw's letters to us on South American Rubbers.
From the "Times of India's" Correspondent at Zanzibar.
Extracts from the Report of the Director, Botanic Gardens, Ceylon, for the years 1880 to 1885.
Notes on Gums, Resins and Waxes, by C. G. Warnford Lock.
From the "American Exporter."
Royal Botanical Gardens, Calcutta, Report for 1880-81 by the Superintendent Dr. Geo. King.

From Kew Gardens Reports.
From the "Gardeners' Chronicle.
From the "Indian Agriculturist."
From the "Boston Journal."
From the "Indian Forester."
From the "Colonies and India."
From the "Demerara Gazette."
From the "Proceedings of the Planters' Association, Kandy."
From the "Boston Commercial Bullittin."
From the "Indiarubber and Guttapercha Journal."
From the "Independent Journal.""
From the "Nilgiri Express."
From the "Spon's Encyclopœdia &c. (Part V).
From the "Revue Francaise."
From the "Public Ledger."
From the "Straits Times."
From the "Barber Brothers Circular."
From the "Rio News."

Respecting the cultivation and harvesting of India-rubber in Ceylon our information as yet is but scanty. Our planters have so far only been acquiring experience, and of late years the great rush into Tea in Ceylon has rather interfered with attention being given to Rubber. Still, a good many have appreciable areas growing, especially of the Ceara tree in Dumbara, Madulsima, Matale, &c. For the latest reports of the progress made, and the experience so far gained in Ceylon, see pages 176-186 for the paper entitled:—"The Rubber Tree Planting Industry in Ceylon in 1887."

In the hope that our compilation may prove of service to the pioneers in what we trust will yet prove an important industry in Ceylon and Southern India, we commend it to the attention of all interested in the subject and especially of all INDIA RUBBER PLANTERS.

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ALL ABOUT INDIA-RUBBER.

(*From the latest Edition of the Encyclopædia Britannica.*)

INDIA-RUBBER, or CAOUTCHOUC, consists of the dried coagulated milky juice of various trees and shrubs, belonging chiefly to the natural orders *Euphorbiaceæ*, *Moraceæ*, *Artocarpaceæ*, and *Apocynaceæ*. Although a milky juice is found in plants of many other families, it does not in all cases yield caoutchouc, nor do different species of the same genus yield an equal quantity or quality of that substance. On the other hand, there are many plants which afford a good rubber, but have not yet been sought out for the commercial purposes. The milky juice of plants furnishing caoutchouc is contained chiefly in the middle layer of the bark, in a network of minute tubes known to botanists as laticiferous vessels. In the *Apocynaceæ* these vessels are found also in the inner bark, or bast layer. The milky juice above-mentioned possesses the properties of a vegetable emulsion, the caoutchouc being suspended in it in the form of minute transparent globules, averaging, according, to Adriani, $\frac{1}{12250}$ inches in diameter. Like other emulsions, it is easily coagulated by the addition of an acid or saline solution,—alum, or salt water being commonly used for this purpose; but it is said by Mr. Bruce Warren not to be coagulated by alcohol. The caoutchouc appears to be kept in suspension in the juice by means of ammonia; at least in some cases the fresh milk exhales an ammoniacal odour. Probably it is on this account that the addition of liquid ammonia prevents the juice from coagulating for a considerable length of time; and the ammonia is in certain districts added when the milk has to be carried some distance from the place of collection. The addition of salt water to the juice is to be deprecated, as it renders the caoutchouc very hygroscopic. The best rubber known is obtained by careful evaporation of the recently strained juice at a moderate heat.

Trees are known to contain caoutchouc by the bark on incision yielding a milk that when rubbed between the fingers coagulates into an elastic fibre. The dried bark of such plants when broken shows between the two fractured surfaces of the bark a number of silky fibres which can be stretched for some distance without breaking.

Caoutchouc differs from other vegetable products of like origin by possessing considerable elasticity, by being insoluble in water or alcohol, alkalies and acids (with the exception of concentrated nitric and sulphuric acids). Although apparently simple in constitution, it contains not only the elastic substance to which its commercial value is due, but a small quantity of an oxidized viscid resinous body soluble in alcohol. This latter substance varies in quantity in different kinds of rubber, those containing the smallest amount, such as the Parà and Ceara, being considered the most valuable, while those in which it is present in greatest proportion, such as the Guatemala and African rubbers,

are the least esteemed. Rapid evaporation of the juice, or any means which prevents oxidation, tends to prevent the formation of this viscid resin.

The first notice of india-rubber on record was given nearly five hundred years ago by Herrera, who, in the second voyage of Columbus, observed that the inhabitants of Hayti played a game with balls made "of the gum of a tree, and that the balls, although large, were lighter and bounced better than the wind-balls of Castile (Herrera, *Historia*, dec. i. lib. iii cap. iv.). Torquemada, however, seems to have been the first to mention by name the tree yielding it. In his *De la Monarquia Indiana*, published at Madrid in 1615. tom ii., cap. xliii. p. 663, he says: "There is a tree which the [Mexican] Indians call Ulequahuitl; it is held in great estimation and grows in the hot country. It is not a very high tree; the leaves are round and of an ashy colour. This tree yields a white milky substance, thick and gummy, and in great abundance." He further states that the juice was collected and allowed to settle in calabashes, and was afterwards softened in hot water, or the juice smeared over the body and rubbed off when sufficiently dry. The tree mentioned by Torquemada has usually been identified as *Castilloa elastica*, Cerv., but the above account cannot apply to it, as that tree is described by Cervantes as one of the loftiest forest trees of the north-east coast of Mexico, and its leaves are not round but oblong-lanceolate. Torquemada mentions also that an oil was extracted from the "ulli," or rubber, by heat, possessing soft and lubricous properties, and of especial effect in removing tightness of the chest. It was also drunk with cocoa to stop hæmorrhage. Even at that early date the Spaniards used the juice of the ulè tree to waterproof their cloaks. This fact, however, apparently did not attract attention in the Old World, and no rubber seems to have reached Europe until long afterwards. The first accurate information concerning any of the caoutchouc trees was furnished by La Condamine, who was sent in 1735 by the French Government to measure an arc of the meridian near Quito.

In 1751 the researches of M. Fresnau, an engineer residing in Guiana, were published by the French Academy, and in 1755 M. Aublet described the species yielding caoutchouc in French Guiana. Nevertheless india-rubber remained for some time unknown in England except as a curiosity, for Dr. Priestly, in the preface to his work on perspective, called public attention to it as a novelty for erasing pencil marks, and states that it was sold in cubical pieces of ½ inch for 3s. each. India-rubber was not known as a product of Asia until 1798, when a plant, afterwards named *Urceola elastica*, Roxb., was discovered to yield it by Mr. J. Howison, a surgeon of Prince of Wales Island, and soon afterwards Assam Rubber was traced by Dr. Roxburgh to *Ficus elastica* Roxb. It was not, however, until the beginning of the 18th century that the indiarubber industry really commenced. The rapid progress which this has made during the last twenty years may be perceived by a glance at the following table:—

Imported into England in the year	1830,	464 cwts.
„ „ „	1840,	6,640 „
„ „ „	1850,	7,616 „
„ „ „	1870,	152,118 „
„ „ „	1879,	150,601 „

It has been computed that in 1870 there were in Europe and America more than 150 manufactories each employing from 400 to 500 operatives, and consuming more than 10,000,000 lb. of caoutchouc. The imports into the United States have largely increased during the last few years.

Botanical Sources, Modes of Preparation, &c.

Notwithstanding the fact that caoutchouc yielding trees are found in a large belt of countries around the globe, including at least 500 miles on each side of the equator, yet the demand for the best qualities of india-rubber is in excess of the supply. The varieties which are almost exclusively used when great elasticity and durability are required are the Pará, Ceara, and Madagascar rubbers.

The principal forms of caoutchouc which are imported into great Britain may be grouped under four heads, the order in which they are here placed

indicating their respective values:—*South American* Pará, Ceara, Pernambuco, Maranhão, Cartagena, Guayaquil; *Central American*—West Indian, Guatemala; *African*—Madagascar, Mozambique, West African; *Asiatic*—Assam, Borneo, Rangoon, Singapore, Penang, and Java. Of all these, the most important is the Pará, the imports of which, according to Messrs. Hecht, Levis, & Kahn, have increased from 1,670 tons in 1857 to 8000 tons in 1879. For this rubber and the Mosambique variety the demand increases every year,—an unerring indication of their value.

I. SOUTH AMERICAN.—*Para rubber* is obtained chiefly from *Hevea brasiliensis*, Müll. Arg., a large euphorbiaceous tree upwards of 60 feet in height, branching from the base, and heaving trifoliate leaves, the leaflets being lanceolate and tapering at both ends (figs 1, 2). Other species of *Hevea*, as well as *Micrandra siphonoides* and *M. minor*, Benth., all of which grow abundantly in the moist steamy valleys of the Amazon and its tributaries, are also used indiscriminately by the natives to furnish Pará rubber. These trees are found in different districts, but all flourish best on rich alluvial clay slopes by the side of rivers, where there is a certain amount of drainage, and the temperature reaches from 89° to 94° at noon, and is never cooler than 73° at night, while rain is rarely absent for ten days together. The genus *Hevea* was formerly called *Siphonia*, and the tree named Pao de Xerringa by the Portuguese, from the use by the Omaqua Indians of squirts or syringes made from a piece of pipe inserted in a hollow flask-shaped ball of rubber.

The caoutchouc is collected in the so-called dry season between August and February. The trees are tapped in the evening, and the juice is collected on the following morning. To obtain the juice a deep horizontal incision is made near the base of the tree, and then from it a vertical one, extending up the trunk, with others at short distances in an oblique direction. Small shallow cups made from the clayey soil and dried in the sun are placed below the incisions to receive the milk, each cup being attached by sticking a piece of soft clay to the tree and pressing the cup against it. The juice, of which each tree yields only about 6 ounces in three days, has a strong ammoniacal odour, which rapidly goes off, and in consequence of the loss of ammonia it will not keep longer than a day unchanged, hence when it has to be carried to a distance from the place of collection 3 per cent of liquid ammonia is added. The juice is said by Bruce Warren to yield half its weight ofcaoutchouc, but 32 per cent appears to be the usual quantity. To obtain the rubber the juice is heated in the following manner:—A piece of wood about 3 feet long, with a flattened clay mould at one end of it, is dipped in the milk, or this is poured over it as evenly as possible. The milk is then carefully dried by turning the mould round and round in a white vapour obtained by heating certain oily palm nuts, those of *Attalea excelsa* being much preferred, and the vapour being confined within certain limits by narrowness of the neck of the pot in which the nuts are heated. Each layer of rubber is allowed to become firm before adding another; a practised hand can make 5 or 6 lb. in an hour. From whatever cause, the rubber thus prepared is the finest that can be obtained. The cakes when completed are, in order to remove them from the mould, slit open with a sharp knife, which is kept wet, and are hung up to dry. The flat rounded cakes of rubber made in this manner are known in the London market as "biscuits." They rarely contain more than 15 per cent of moisture. The scrapings from the tree, which contain fragments of wood, are mixed with the residues of the collecting pots and the refuse of the vessels employed, and are made up into large rounded balls, which form the inferior commercial quality called "negrohead," and often contain 25 to 35 per cent of impurity. An intermediate quality is known as "entre-fine." Pará rubber is said to be sometimes adulterated with the juice of the Macandaruba tree (*Mimusops elata*), which might account for the great differences that have been occaisonally observed in the behaviour of Pará

rubber in certain stages of manufacture, the coagulated juice of the *Mimusops* genus resembling gutta percha rather than caoutchouc.

Previous to 1860 Pará rubber was exported only in small quantities, and then chiefly in the form of shoes; this variety ceased to be sent over in 1852. Occasionally "negrohead" has been imported in grotesque forms of animals, &c., and the better qualities in the shape of small bottles moulded in soft clay which has been afterwards washed out by water.

In British Guiana rubber is obtained from *Hevea paucifolia*, Müll. Arg.; in French Guiana from *H. Guayanensis*, Aubl., where it is known as "heve," "siringa," or "cahoutchou,"—the last being the probable origin of the name caoutchouc; and in Venezuela, from *H. brasiliensis*, there called dápi or dápiche. None is exported to England from any of these localities. Small quantities of rubber intermediate in character between that of Pará and Pernambuco are occasionally imported from Maranhão. On account of its great value as a source of caoutchouc, the cultivation of the Parà rubber tree has been attempted in India; but it has been found to be too tropical a plant for cultivaton in northern and central India, although suitable for Ceylon, Malabar, and South Burmah, according to recent reports. The seeds, which are about the size of a damson (fig. 2. *d*), soon lose their vitality, and cuttings do not thrive unless taken from the young wood.

Ceara rubber is considered almost next to the Pará in value, as it is a "dry" rubber, very elastic and free from stickiness; but it often contains a quantity of wood and foreign matter arising from the mode of collecting it, the loss in washing previous to manufacture amounting sometimes to 25 per cent. It is the produce of *Manihot Glaziovii*. Müll, Arg, a euphorbiaceous tree common in the province of Rio Janeiro, about 30 feet high, with a rounded head of foliage, and greyish-green 3 to 7-lobed palmate leaves, somewhat resembling the leaves of the castor oil plant in shape and size (figs. 3, 4, 5). The trees are tapped, according to Mr. R. Cross, when the trunk attains a diameter of 4 to 5 inches, *i. e.*, when they are about two years old. The mode of collecting the rubber is as follows:—After brushing away the loose stones and dirt from the root of the tree by means of a handful of twigs, the collector lays down large leaves for the milk to drop upon. He then slices off the outer layer of the bark to the height of 4 or 5 feet. The milk, which exudes in many tortuous courses, some of it ultimately falling on the ground, is allowed to remain on the tree for several days, until it becomes dry and solid, when it is pulled off in strings, which are either rolled up into balls or put into bags in loose masses, in which form it enters commerce under the name of Ceara "scrap." The amount of Ceara rubber imported in 1879 ammounted to 500 cwt. The attempts which have been recently made to cultivate this rubber plant in India have been attended with signal success. In Rio Janeiro it grows in a rocky or stony arid region, where a short underscrub is the only vegetation, and the atmosphere is hot and dry, the temperature ranging from 82° to 90° Fahr. It is, therefore, suited for cultivation where the *Hevea* will not grow. In Ceylon it has been found to thrive at an altitude of from 200 feet to 3,000 feet above the sea-level. At Zanzibar and Calcutta also it succeeds well. The seeds (fig. 5, *c*), which have a hard thick coat, take a year in germinating, unless the edges near the end bearing the caruncular projection are rasped off. Cuttings, provided they have a single bud, strike readily.

Pernambuco or *Mangabeira rubber* is obtained from *Hancornia speciosa*, Gom., an apocynaceous tree common on the South American plateau in Brazil from Pernambuco to Rio Janeiro, at a height of 3 000 to 5,000 feet above the sea. It is about the size of an ordinary apple tree, with small leaves like the willow, and a drooping habit like a weeping birch, and has an edible fruit called "mangaba," for which, rather than for the rubber, the tree is cultivated in some districts. Only a small quantity of this rubber comes to England, and it is not much valued, being a "wet" rubber. It occurs in "biscuits" or "sheets." The caoutchouc is collected in the following manner;—

About eight oblique cuts are made all round the trunk, but only through the bark, and a tin cup is fastened at the bottom of each incision by means of a piece of soft clay. The cups when full are poured into a larger vessel, and solution of alum is added to coagulate the juice. In two or three minutes coagulation takes place, and the rubber is then exposed to the air on sticks, and allowed to drain for eight days. About thirty days afterwards it is sent to market. Pernambuco rubber, as is the case with most rubbers coagulated by saline solutions, contains a large quantity of water.

Cartagena rubber comes from New Granada in the form of black sheets ¾ inch thick having a somewhat rough or "chewed" appearance, and is more or less "tarry" or sticky. It also occurs in the form of strips or small pieces pressed together in bags. Its botanical source is not known, but is thought to be a pinnate-leaved tree, a portion at least being derived, it is supposed, from *Castilloa elastica*. It loses 35 per cent of moisture when dried. The importation of Cartagena rubber into Great Britain has declined from 3,518 cwt. in 1875 to 1,679 cwt. in 1879.

Guayaquil rubber is imported from Ecuador in large flakes or lumps, of a whitish colour in the best kinds, the inferior sorts being porous and filled with a fœtid black liquid, having an odour of cow-dung, and staining the knife and hands. It is believed to be obtained from *Castilloa elastica*. The amount imported into Britain has diminished from 3815 cwt. in 1875 to 482 cwt. in 1879. In washing for manufacture it sometimes loses up to 40 per cent of its weight. The bulk of the two last mentioned rubbers is exported to the United States.

II. CENTRAL AMERICAN.—The source of all the principal rubbers exported from Central America is *Castilloa elastica*, Cerv., a lofty artocarpaceous tree, with a trunk 3 feet or more in diameter, and large hairy oblong lanceolate leaves often 18 inches long and 7 inches wide, those subtending the young branches being much smaller and more ovate (fig 6). The tree grows most abundantly in a sporadic manner in the dense moist forests of the basin of the Rio San Juan, where the rain falls for nine months in the year. It prefers rich fertile soil on the banks of watercourses, but does not floursish in swamps. It is found also in Costa Rica, Gautemala, Honduras, Mexico, Cuba and Hayti, and in Panama in company with another species, *C. Markhamiana*, Collins and on the west coast of South America down to the slopes of Chimborazo, the Cordilleras of the Andes separating the *Castilloæ* from the *Heveae* of Brazil, according to Mr. R. Spruce.

Nicaragua rubber.—In Nicaragua the juice is collected in April, when the old leaves begin to fall and the new ones are appearing, during which time the milk is richest. The tree is tapped either in the same manner as the *Hevea*, or by encircling the tree with a simple spiral cut at an inclination of 45°, or by two spirals in opposite directions if the tree be large. At the bottom of the spiral an iron spout about 4 inches long is driven into the tree, and the milk is received in iron pails. A tree 20 to 30 feet high to its first branches, and about 4 feet in diameter, is expected to yield 20 gallons of milk, each gallon giving about 2lb. of rubber. In the evening the milk is strained through a wire sieve and transferred to barrels. The milk is coagulated by the addition of the juice of the "acheté" plant (*Ipomœa bona-nox*, L) or of another plant called "coasso." The strained juice of either of these plants, obtained by bruising the moistened herb and subsequent expression, is added to the milk in the proportion of about 1 pint to the gallon. If these plans are not procurable, two parts of water are added to one of the milk, and the mixture allowed to stand for twelve hours. The coagulum is next flattened out by a wooden or iron roller to get rid of the cavities containing watery liquid, and the sheets are then hung up for fourteen days to dry, when they weigh about 2 lb., the sheets being usually ½ to ⅛th inch thick and 20 inches in diameter. When coagulated by water, the mass is placed in vats in the ground and allowed to dry, this taking place in about a fortnight. It is then rolled into balls,

That which dries on the incisions in the tree is called bola or burucha, and is said to be highly prized in New York. The loss of Nicaragua rubber in drying is estimated at 15 per cent. It is exported chiefly from San Juan del Norte, or Grey Town, and the larger proportion goes to the United States. The *Castilloa* appears to be suitable for cultivation only in districts where the Pará rubber would grow equally well. The deciduous lateral shoots if planted will never grow erect.

West Indian rubber is the variety usually imported into England, but in comparatively small quantity only. It occurs in the form of blocks, the finest quality consisting of thin separable sheets, and the second of "scraps," usually conglomerated and containing fragments of bark. It is the best description of Central American rubber known. It is not, as its name seems to imply, produced in the West Indies, but derives its appellation from being brought over in West Indian steamers.

Honduras rubber rarely comes over to England: it is of good quality, and free from "tarry" matter.

Mexican rubber is imported into Liverpool in small quantity only. The imports of Mexican caoutchouc decreased from 1,292 cwt. in 1875 to 158 cwt. in 1879.

Guatemala rubber is a very inferior kind and very unequal in quality; the best varieties are whitish, and the "lower" are black with a "tarry" appearance. It occurs in the form of sheets compacted together, from between which when pressed a thick resinous fluid exudes. This when evaporated leaves a hard resinous substance unaffected by hot water or steam. The rubber is collected from the trees as in Nicaragua, but it is poured on mats to dry, and the thin sheets are subsequently peeled off, folded into squares, and subjected to pressure to remove as much as possible of the contained moisture. The imports of india-rubber into England from the whole of Central America amounted only to 2,080 cwt. in 1879, having decreased from 5,809 cwt. in 1875. The greater proportion of Central American rubber is exported to New York, especially that from Nicaragua and Panama.

Siphocampylus Caoutchouc, Don., and *S. Jamesonianus*, D. C., Central American plants belonging to the natural order *Lobeliaceae*, are also stated to yield rubber of good quality; and at the Philadelphia exhibition a rubber called Durango caoutchouc, obtained from a composite plant, was exhibited.

III. African.—India-rubber is produced throughout equatorial Africa, the chief districts of export being the Gaboon, Congo, and Benguela on the west coast, and Madagascar Mozambique, and Mauritius on the east. The Madagascar, Mauritius, and Gaboon rubbers are, it is believed, chiefly exported to France. Those which enter into British commerce are known as Mozambique, Madagasear, and African, although the imports are described as coming from the following districts in the blue books:—Senegambia and Sierra Leone 3,808 cwts., West Coast 11,307 cwt., East Africa 7621 cwt., Cape of Good Hope 4,241 cwt., Mauritius 570 cwt., Gold Coast 12 cwt. The above imports, which are for 1879, shew an increase during the past five years, except in the case of Mauritius, Madagascar, and the Gold Coast. Africa in respect of the large amount exported, may now be considered as taking the second place as an india-rubber producing continent.

Mozambique rubber, which is one of the most important varieties, occurs in the form of balls about the size of an orange, and "sausages," or spindle shaped pieces made up of slender strings of rubber wound around a piece of wood, which is eventually removed; or sometimes it occurs in smooth pieces of irregular size known as "cake" or "liver" *Madagascar rubber* consists of two qualities, the best of a pink and the inferior or "lower" of a black colour, and occurs in shapeless pieces.

The other kinds included under the general name of African are amorphous lumps called "knuckles" from Congo; small "negroheads" or "balls" of scrap, and smooth cakes from Sierra Leone; small square pieces like dice called

"thimbles," and others more irregular in shape called "nuts," and "small negro-heads" from the Portuguese colonies; "tongues," consisting of flat pieces, usually wet and sticky, from the Gaboon; and "balls" from Liberia. African rubber, as a rule, possesses more adhesiveness and less elasticity than Pará rubber, and is inferior in value. Comparatively little is known of the plants yielding caoutchouc in Africa or of the mode of collection. In Angola, according to Dr. Welwitsch, the natives either cut off a piece of bark, and allow the milky juice to run into a hole in the ground, or placing the hand against the trunk of the tree permit the milk to trickle down their arms, going from tree to tree, until the arm is covered, when the rubber is rolled back towards the hand in the form of a ring. The wood of some of the trees, according to Mr. Collins, contains a gum which, if the incision penetrates below the bark, mixes with the rubber and deteriorates it. In Madagascar, according to M. Coignet, rubber is obtained from the "Voà-héré" or "Voà-canja," *Vahea madagascariensis*, Boj., the "Voà-biné, *V. comorensis*, Boj., and from *V. gummifera*, Lam. In Senegambia it is obtained from the "Anjouan" *Vahea senegalensis*, A. D. C. In Mauritius *Willughbeia edulis*, Roxb. (which is found also in Madagascar, and in Chittagong and Silhet in India), appears to be the chief source of rubber. All the above are climbing shrubs with opposite entire leaves and fleshy fruits.

In Central Africa, from Liberia on the one side to Zanzibar on the other, caoutchouc is collected from plants of genera nearly allied to *Vahea*, a few only of the species being known to botanists. In Angola, under the name of "Licomgue," in Golungo Alto and Cazengo, it is collected from *Landolphia owariensis*, Pal. de Beauv.; from *L. florida*, Benth., in Angola and Liberia, and from *L. Hendelotii*, D. C. in Senegal. At Kew there also exists a specimen of indiarubber from the west coast of Africa obtained from an undescribed species of *Carpodi us* with hairy leaves and stems. In the basin of the Gaboon and Congo it is obtained, according to Du Chaillu, from a climbing plant called *N'dambo*, which gives its name to dambonite, a peculiar substance contained in this kind of rubber (see p. 11). That some African caoutchouc is yielded by species of *Ficus* there can be no doubt. In Sierra Leone it is collected from *Ficus Brasii*, R. Br. In Liberia, according to Mr. Thomas Christy, the finest rubber is obtained from *Urostigma Vog lii*, Miq., a tall tree with large handsome leaves, and lower qualities of rubber from other species, and from *Landolphia florida*, Benth. In Angola on the west, and at Inhambane on the east coast, rubber is also obtained from species of *Ficus*. In the Island of Rêunion caoutchouc is said to be obtained from *Periploca graeca*, L.

IV. Asiatic.—The rubbers which enter English commerce from Asia include the Assam, Borneo, Rangoon, Singapore, Penang, and Java kinds.

Assam rubber is imported chiefly from Calcutta in baskets made of split rattans, weighing about 3 cwt. each, and covered with a gunny bag. The rubber is glossy, of a bright pink colour and mottled appearance, and occurs in the form either of small balls pressed together or of irregular masses called "slabs" or "loaf" rubber. The former, being more liable to adulteration, are less in demand by manufacturers. The imports into Liverpool in 1879 were 7,000 cwt. Assam rubber is obtained from *Ficus elastica*, Roxb., a plant too well known as a window ornament to need description. A portion also is collected from *Urostigma laccifera*, Miq. *Ficus elastica* grows in the tropical rocky valleys of the Himalayas, between 70° and 80° E. long., where there is always a hot moist atmosphere, the temperature rising to 98° F. in the shade. The trees are tapped in the most careless manner. In the lower portion of the tree and in the large aerial roots, diagonal cuts penetrating to the wood are made, from 6 to 18 inches long, and in an elliptical form so as to be about 3 inches across the centre. The milk is received either in holes made in the ground or in leaves folded in the form of a funnel, that form the smaller cuts on the branches (for the collectors scarify every portion within reach) being allowed to dry on the tree. About 50 oz. of the milk collected in August gives 15 oz. of caoutchouc, but the percentage sometimes falls as low as 10 per cent. From

February to April the milk is more scanty, but richer in caoutchouc, and is consequently best collected at that time. The milk is coagulated by pouring it into boiling water and stirring it until it is sufficiently firm to be carried about without being clammy; sometimes it is pressed, again boiled and dried in the sun. In this way the "loaf" rubber in irregular masses is formed. The small "balls" are formed of the strings of rubber which have been allowed to dry on the tree.

Assam rubber, although fairly elastic, is much depreciated in value by the careless mode of collection, and often loses, by washing at the manufactory, as much as 35 per cent of dirt, consisting of clay, sand, or bark. The exportation of caoutchouc from British India, exclusive of ths Straits Settlements and Ceylon, in 1879 amounted to 9,973 cwt., of which 7,000 are estimated to have been produced in Assam. About three-fourths of the rubber exported from India goes to Great Britain, and the remainder to the United States.

In consequence of the reckless destruction of the trees, the cultivation of *Ficus elastica* has been commenced in Assam. It is calculated that the trees can be tapped at the age of twenty-five years, and that after fifty years they will yield 40 lb. of caoutchouc each (worth £3 4s.) every three years, it being injurious to their health to tap them more frequently.

Palay rubber is the product of *Cryptostegia grandiflora*, R. Br. an asclepiadaceous plant common on the coast of India; and form *Willughbeia edulis*, Roxb., and *W. martabanica*, D. C, a rubber is obtained in Chittagong; neither of these, however, is known in Britain as a commercial variety.

Borneo rubber comes to the Liverpool market in the form of balls or shapeless masses, internally of a white or pinkish colour, and very porous and spongy, the pores being usually filled with salt water, in consequence of which it often loses 20 to 50 per cent of its weight in drying. The imports into Great Britain amounted in 1879 to 5,000 cwt. Although Borneo rubber was first made known in 1798, it was not imported into England as an article of trade till 1864, when it appeared under the name of gutta susu, *i. e.*, in Malayan, milk-gum. The plant which yields Borneo rubber was indentified by Roxburgh as *Urceola elastica*, Roxb. an apocynaceous climbing plant with a trunk as thick as a man's body, and having a soft thick bark. Mr. F. W. Burbidge, who recently visited the island, states that there are three varieties of the rubber plant, known to the natives as "petabo," which yields the finest caoutchouc; "menoongan," which yields the largest quantity; and "serapit," from which the commonest rubber is obtained. The petabo variety, according to specimens at Kew, is referred to a species of *Leuconotis*. The rubber is obtained by cutting the plant into pieces varying from a few inches to 2 or 3 feet long, and allowing the juice to drain into buckets or jars, heat being sometimes applied to one end of the pieces when the juice flows slowly. The milk is coagulated by salt water. The Borneo rubber plants is probably one of the plants that would repay cultivation, as it grows rapidly, yields a supply of sap in three years, and after planting requires no attention.

In Sumatra, caoutchouc is obtained from *Willughbeia firma*, and is exported to Holland, but this variety is not known in England. Malacca rubber, which is not met with in English commerce, is said to be obtained from *Urceola elastica*, Roxb.

Rangoon rubber, and those of Penang and Java, are imported into England in small quantities only, and are irregular in appearance. From its physical characters, a portion at least of Rangoon rubber is believed to be the produce of a species of *Ficus*, probably *F. hispida*, L. Another caoutchouc-yielding plant, *Urceola* (*Chavannesia esculenta*, Benth., belonging to the *Apocynaceae*, has, however, been recently discovered in Burmah, some specimens of which at the age of five yeare have stems 6 inches in diameter, while the crown covers an area of 200 square feet. It has been recommended for plantations as an available source of rubber, the cost of cultivation being very

slight after the first year, and the profit commencing in seven years, at which age the yield is calculated to be $3\frac{1}{2}$ lb.

Penang rubber in character resembles the Assam, and may be also supposed to be obtained from a species of *Ficus*. Dr. Wallich, however, has stated that its source is an asclepiadaceous plant, *Cynanchum ovalifolium*, Wright.

Java rubber is stated by Dr. De Vrij to be obtained from *Ficus elastica*. Like the Assam rubber it is dark and glossy, but it is of a deeper tint, and has occasional reddish streaks. It is said to be prepared by allowing the juice to dry on the incisions made in the tree. Singapore, Java, and Penang rubbers are much alike in character, and may be classed with the Assam rubber, having a firm texture, mottled appearance, and bright polished surface, but varying in colour in a single sample from light yellowish-white to dark brown. Java rubber is also exported to France.

Caoutchouc is obtained in the Malay archipelago from *Alstonia costulata*, Miq.; and *Alstonia scholaris*, R. Br., is likewise reported to yield it. In Fiji it has been obtained from *Alstonia plumosa*, Labill. In North Australia caoutchouc has been prepared from *Ficus macrophylla*, Desf., and *F. rubiginosa*, Desf.; the last-named plant has been recommended by Baron Müller as suitable for cultivation, being a hardy species. None of the above rubbers are as yet known in British commerce as regular aricles of trade.

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CHEMISTRY, MANUFACTURE, AND INDUSTRIAL USES.

The remarkable body known as india-rubber is composed of carbon and hydrogen alone, but its exact chemical nature is not by any means known with certainty. The analyses of Farady indicate that its ultimate composition is 87·5 per cent of carbon and 12·5 per cent of hydrogen; but there appears to be good ground for regarding the substance as a polymer of the group $C_{10}H_8$, or as $(C_{10}H_8)x$. There are, however, no data for estimating the value of x in this case. It will be noticed, too, that the formula given requires considerably less hydrogen than the proportion indicated by Faraday's analysis; but the difficulties of obtaining such a body as caoutchouc in a fit condition for analysis are so great as to render this discrepancy a matter of comparatively small import. The action of cold and heat on india-rubber presents many points of interest. When exposed to a temperature approaching 0° C., it gradually loses its softness and ready extensibility, and finally becomes rigid and inelastic; but its normal condition may be restored by submitting it either to a temperature of 35° or 40° C., or to a tension sufficient to stretch it to about twice its natural length. In the latter case it is probable that the change is really due to heat arising from the physical disturbance consequent upon the act of stretching. The effects of heat are more complex and varied than those of cold; and with caoutchouc at an ordinanry temperature say 15° C., the primary effect of heat is to increase its flexibility and elasticity. This is well illustrated by the fact that a strip of rubber stretched by a weight contracts when it is heated to a temperature of about 40° C. This diminution as regards length is, however, accompanied by a more than corresponding increase in thickness, on account of the expansion in volume due to an elevated temperature. When caoutchouc is exposed to a temperature ranging between 100° and 120° C., it becomes considerably softened, and almost entirely loses its elasticity; but, if of good quality, it slowly recovers its former condition under the influence of

a moderate degree of cold. When, however, the heat is pushed to 150°, it becomes viscous, and at 200° it fairly melts, forming a thick liquid which possesses the same composition as ordinary caoutchouc, but has no tendencey to resume its original condition even when exposed to cold for a prolonged period. At a still higher temperature, caoutchouc yields a variety of volatile hydrocarbons; and on subjection to dry distillation in a retort, its conversion into these bodies is tolerably complete, only a trifling carbonaceous residue remaining behind. Among the most notable volatile products resulting from the dry distillation of caoutchouc may be mentioned *caoutchin*, an oil-like body having a composition and vapour volume corresponding to the formula $C_{10}H_8$, and boiling at 171° C.; and *isoprene*, another hydrocarbon oil identical in composition with caoutchin and with caoutchouc itself, and boiling at 38° C. Other hydrocarbon oils are also formed, as, for example, *heveene* and *caoutchene*,—these being members of the C_nH_{2n} series. The former boils at 228°, and the latter at 14°·5. The mixed products of the dry distillation of caoutchouc, often described under the name caoutchoucin, form an excellent but rather expensive solvent of this body. When exposed to the air, caoutchouc gradually oxidizes and undergoes deterioration; the oxidation is often much favoured by exposure to sunlight or to alternate conditions of dampness and dryness. The deteriorated caoutchouc is either somewhat soft and deficient in tensile strength, or brittle and resinous in its nature. Spiller found 27·3 per cent of oxygen in a resinous product resulting from the decay of caoutchouc. Ozone rapidly attacks and destroys the substance.

Dilute acids or alkalies have little or no action on caoutchouc, but strong and hot sulphuric acid chars, and concentrated nitric acid rapidly oxidizes and destroys it. The moderate action of either chlorine, bromine, or iodine hardens or vulcanizes it; but, if allowed to act freely, they completely destroy it. The action of sulphur will be considered below.

Caoutchouc, when pure is odourless and nearly white, and possesses a specific gravity of ·915. It is porous and cellular in texture, and absorbs from 10 to 25 per cent by weight of water when long soaked in it. Alcohol is similarly taken up. Up to this point caoutchouc has been referred to as if it consisted of one substance only; but as a matter of fact all ordinary samples contain two distinct modifications, viz, the hard or fibrous and the soft or viscous. These two caoutchoucs are identical in composition, and similar as regards general properties and reactions. On subjecting a piece of raw caoutchouc, however, to the action of such a solvent as cold benzol, the essential difference between the two forms manifests itself. The fibrous or hard constituent merely swells up to many times its original bulk, but the viscous yields a true solution. In a high class rubber, such as that imported from the province of Pará, the former modification is the principal factor; in a caoutchouc of low quality, such as "African tongue," the latter. Freshly cut surfaces of caoutchouc unite together firmly; and this circumstance is due to the presence of the viscous variety; vulcanization, by hardening this, destroys the adhesive property

Certain liquids, such as benzol and its homologues, carbon disulphide, petroleum, ether, volatile oils, chloroform, and melted naphthalene, dissolve caoutchouc more or less perfectly; but unless the substance has been subjected to the process of mastication, its fibrous constituent appears, not to dissolve in the strict sense of the term, but rather to swell up forming a past analogous to starch which has been acted on by hot water. Carbon disulphide and chloroform, however, exercise a more powerful solvent action on the fibrous parts of india-rubber than benzol or essential oils; and Payen has found that carbon disulphide to which 5 per cent of absolute alcohol has been added forms one of the best solvents. One part of masticated caoutchouc dissolved in thirty parts of this solvent forms a liquid which can be filtered through paper, and which leaves a film of exquisite tenuity and purity when allowed to dry on a level glass plate.

Most fatty matters exercise a remarkable destructive action on caoutchouc, causing it to become first soft, and afterwards hard and brittle. It has often happened that traces of fatty oils in the liquids employed for dissolving india-rubber, or fatty matters in the textile basis, have led to the destruction of waterproof goods. A like cause has in many cases led to the rapid deterioration of the caoutchouc threads in elastic webbing.

In the industrial working of india-rubber, the first matter to be attended to is the removal of the various impurities present in the crude material. These are in some cases natural products which have originated with the caoutchouc, while in other cases they owe their presence to careless collection or to adulteration. Among the impurities of the former class may be mentioned various gum-like or mucilaginous matters, and acid products arising from their decay or oxidation. A remarkable volatile body, which is probably of the nature of a polyatomic alcohol, has been discovered by Gerard* in the crude caoutchouc from the Gaboon. This substance, called by the discoverer *dambonite*, has a composition corresponding to the formula $C_4H_8O_3$, is sweetish to the taste and soluble in water, and crystallizes in needles which melt at 190° C. and volatilize between 200° and 210°. The admixtures may range from fragments of bark or wood to stones or large lumps of clay, such as are sometimes introduced into negrohead rubber,—hay or a similar substance being also placed inside to make the mass about equal in specific gravity to the genuine article. Alum and sulphuric acid are often employed to effect the coagulation of the juice; and traces of the latter remaining in the rubber appear, in some instances, to work mischief.

All the above-mentioned impurities are in actual practice very efficiently removed by the following process:—The lumps of crude caoutchouc are first softened by the prolonged action of hot water, and then cut into slices by means of a sharp knife,—generally by hand, as thus any large stones or other foreign substances can be removed. The softened slices are now repeatedly passed between grooved rollers, known as the washing rollers (fig. 7), a supply of hot or cold water being made to flow over them. Solid impurities speedily become crushed, and are carried away by the water, while the rubber takes the form of an irregular sheet perforated by numerous holes. The washed product contains in its pores a notable proportion of water, which is removed by hanging the rubber for some days in a warm room. It is now ready either for incorporation with sulphur and other solid bodies, or for agglomeration into solid masses by means of the masticating machine,—an apparatus which consists of a strong cylindrical cast-iron casing, inside which there revolves a metal cylinder with a fluted or corrugated surface. Some of the rubber having been placed in the annular space between the inner cylinder and the outer casing, the former is made to revolve; and the continued kneading action to which the rubber is subjected works it into a solid mass, something like a gigantic sausage. Before commencing the mastication it is generally necessary to warm the apparatus by means of steam; but as the operation proceeds the heat produced requires to be moderated by streams of cold water flowing through channels provided for the purpose. The inner cylinder is generally placed somewhat excentrically in the outer casing, in order to render the kneading more perfect than would otherwise be the case.

To convert the masticated rubber into rectangular blocks, it is first softened by heat, and then forced into iron boxes or moulds. The blocks are cut into thin sheets by means of a sharp knife, which is caused to move to and fro about two thousand times per minute, the knife being kept moistened with water, and the block fed up to it by mechanical means. Cut sheets are largely used for the fabrication of certain classes of rubber goods,—these being made by cementing the sheets together with a solution of rubber in coal-naphtha or benzol. Most articles made of cut sheets rubber would, however, be of very limited utility were they not hardened, or vulcanized by the action of sulphur or some

* *Compt. Rend.*, lxvii. p. 820, and *Zeitschrift für Chem.*, 1869, p. 66.

compound of that element. After vulcanization, rubber is no longer softened by a moderate heat, a temperature of 160° C. scarcely offecting it, nor is it rendered rigid by cold, and the ordinary solvents fail to dissolve it. It must, however, be distinctly understood that it is not the mere admixture but the actual combination of sulphur with india-rubber that causes vulcanization. If an article made of cut sheet be immersed for a few minutes in a bath of melted sulphur, maintained at a temperature of 120° C., the rubber absorbs about one-tenth of its weight of that element, and, although somewhat yellowish in colour from the presence of free sulphur, it is still unvulcanized, and unaltered as regards general properties. If, however, it be now subjected for an hour or so to a temperature of 140° C., true combination sets in, and vulcanized caoutchouc is the result. When a manufactured article has been saturated with sulphur in the melted-sulphur bath, the heat necessary for vulcanization may be obtained either by high-pressure steam, by heated glycerin, or by immersion in a sulphur-bath heated to about 140° C. In this last case absorption of the sulphur and its intimate combination with the rubber occur simultaneously. Cut sheets, or articles made from them, may be saturated by being laid in powdered sulphur maintained for some hours about 110° C. Sheets sulphured in this way can be made up into articles and joined together either by warming the parts to be united, or by means of india-rubber solution; after which the true vulcanization, or "curing" as it is termed, can be brought about in the usual way. Another method of vulcanizing articles made from cut sheet rubber consists in exposing them to the action of chloride of sulphur. Either they are placed in a leaden cupboard into which the vapour is introduced, or they are dipped for a few seconds in a mixture of one part of chloride of sulphur and forty parts of carbon disulphide of purified light petroleum. Vulcanization takes place in the instance without the action of heat; but it is usual to subject the goods for a short time to a temperature of 40° C. after their removal from the solution, in order to drive off the liquid which has been absorbed, and to ensure a sufficient action of the chloride of sulphur. Treatment with a warm alkaline solution is afterwards advisable, in order to remove traces of hydrochloric acid generated during the process. Another very excellent method of vulcanizing cut sheet goods consists in placing them in a solution of the polysulphides of calcium at a temperature of 140° C. Rubber employed for the manufacture of cut sheet is often coloured by such pigments as vermilion, oxide of chromium, ultramarine, orpiment, antimony, lamp black, or oxide of zinc, incorporation being effected either by means of the masticator or by a pair of rollers heated internally by steam and so geared as to move in contrary directions at unequal speed. Most of the rubber now manufactured is not combined with sulphur when in the form of sheets, but is mechanically incorporated with about one-tenth of its weight of that substance by means of the mixing rollers,—any required pigment or other matters, such as whiting or barium sulphate, being added. The mixed rubber thus obtained is readily softened by heat, and can be very easily worked into any desired form or rolled into sheets by an apparatus known as the calendering machine. Vulcanization is then ensured by exposure for half an hour or more to a temperature of 135°—150° C., usually in closed iron vessels into which high-pressure steam is admitted. Tubes are generally made up around mandrels, and allowed throughout the curing to remain imbedded in pulverized French chalk which affords a useful support for many articles that tend to lose their shape during the process. Of late years a considerable amount of seamless tubing has been made, much in the same way as lead piping by forcing the mixed rubber through a die, and curing as above. The calendered sheets are generally cured between folds of wet cloth, the markings of which they retain; and hollow articles, such as playing balls or injection bottles, are vulcanized in iron or brass moulds, tinned inside and very slightly greased. Before it is put in, the article is roughly put together, and the expansion of the included air forces the rubber into contact with the internal surface of the mould, or a little carbonate of ammonia is enclosed. Belting intended for driving machin-

ery is built up of canvas which has been thoroughly frictioned with the soft mixed rubber, and is cured by placing it in a kind of press kept by means of steams at a dry heat of about 140° C. Packing for the stuffing boxes of steam engines is similarly prepared for strips of rubber and frictioned canvas, as also are the so-called insertion sheets, in which layers of rubber alternate with canvas or even wire gauze. India-rubber stereotypes are now extensively made use of as hand stamps, and attempts have been made to introduce them for press and machine printing. A plaster cast of the type is, when dry, saturated with shellac varnish and re-dried. Rubber mixed in the usual way with about 10 per cent of sulphur is now softened by heat, forced into the mould, and retained there by pressure during the operation of curing, which is usually effected in an iron box heated over a gas burner to 140° C.

The ordinary macintosh or waterproof cloth is prepared by spreading on the textile fabric layer after layer of india-rubber paste or solution made with benzol or coal-naphtha. If cotton or linen is used it is usual to incorporate sulphur with the paste, and to effect vulcanization by steam heat; but, when silk or wool is employed, no sulphur is added to the paste, the dried coating of rubber being merely brought into momentary contact with the mixture of chloride of sulphur and carbon disulphide already mentioned. Double texture goods are made by uniting the rubber surfaces of two pieces of the coated material. Air goods, such as cushions, beds, gas bags, and so forth, are made of textile fabrics which have been coated with mixed rubber either by the spreading process above described, or by means of heated rollers, the curing being then effected by steam heat. The manufacture of overshoes and fishing boots is an analogous process, only the canvas base is more thickly coated with a highly pigmented rubber of low quality. The articles are first fashioned by joining the soft material; they are then varnished, and afterwards cured in ovens heated to about 135° C. The fine vulcanized "spread sheets" are made by spreading layers of india-rubber solution, already charged with the requisite proportion of sulphur, on a textile base previously prepared with a mixture of paste, glue, and treacle. Vulcanization is then effected by steam heat, and the preparation on the cloth being softened by water, the sheet of rubber is readily removed. The required thickness of the spread sheet is very often secured by the rubber-faced surfaces of two cloths being united before curing. The threads used in making elastic webbing are usually cut from spread sheets. The manufacture of springs, valves, and washers does not require any very special notice, these articles being generally fashioned out of mixed rubber, and vulcanized either in moulds or in powdered French chalk. Rollers are made to adhere to their metal spindles by the intervention of a layer of ebonite, and after vulcanization they are turned. In order to make spongy or porous rubber, some material is incorporated which will give off gas or vapour at the vulcanizing temperature,—such as carbonate of ammonia, crystallized alum, and finely ground damp sawdust. Uncombined sulphur is injurious, and often leads to the decay of vulcanized goods; but an excess of sulphur is generally required in order to ensure perfect vulcanization. Sometimes the excess is partially removed by boiling the finished goods with solution of caustic soda or some other solvent of sulphur. In other cases the injurious effects of free sulphur are obviated by using instead of it a metallic sulphide,—generally the orange sulphide of antimony; but, for the best results, it is necessary that this should contain from 20 to 30 per cent of uncombined sulphur.

When the vulcanization of rubber is carried too far—say from the presence of a very large proportion of sulphur and unduly long action of heat, the caoutchouc becomes hard, horn-like, and often black. Rubber hardened by over vulcanization is largely manufactured under the name ebonite or vulcanite. It is usually made by incorporating about 40 per cent of sulphur with purified Borneo rubber by means of the usual mixing rollers, shaping the required articles out of the mass thus obtained, and heating for six, eight, or ten hours to from 135° to 150°. Ebonite takes a fine polish, and is valuable to

the electrician on account of its insulating properties, and to chemist and photographer because vessels made of it are unaffected by most chemical re-agents. A kind of vulcanite which contains a very large proportion of vermilion is used, under the name of dental rubber, by making artificial gums.

The following list of works and papers on the rubber industry enumerates the writings which are calculated to be especially useful to the enquirer:—Charles Goodyear, *Gum Elastic and its Varieties*, New Haven, U. S. A., 1853; Friedrich Harzer, *Gutta-Percha und Kautschuk, ihr Vorkommen*, &c., Weimar, 1853; Paulin Desormeaux, *Nouveau manuel complet du fabricant d'objets en caoutchouc, en gutta-percha, et en gomme factice* 424 pp., Paris, 1855; C. H. Schmidt, *Der Fabricant von Kautschuk und Gutta-Percha Waaren*, 207 pp., Weimer 1856; Thomas Hancock, *Origin and Progress of the India-Rubber Manufacture in England*, London, 1857; Heinrich Keysserling's edition of Friedrich Harzer's *Gutta-Percha und Kautschuk*, 237 pp., and atlas, Weimer, 1864; *Abridgments of Specifications relating to the Preparation of India-Rubber and Gutta-percha*, 1791-1866, 262 pp., printed by order of the Commissioners of Patents, London, 1875; "India-Rubber and Gutta-Percha," a series of articles in the *Universal Engineer*, vol. ii., Manchester 1879; Franz Clouth, *Die Kautschuk Industrie*, 76, pp., Weimar 1879; T. Bolas, *Cantor Lectures on the India-Rubber and Gutta-Percha Industries*, London, 1880; M. Maigne, *Nouveau manuel complet du fabricant d'objets en caoutchouc*, &c., 2 vols. 506 pp., Paris, 1880.

(T. B.)

(From *Knight's English Cyclopædia*, vol. iii.)

INDIA-RUBBER, the common name of a vegetable compound which is found in all plants with a milky juice. It is also known by the name of Caoutchouc.

The existence of a milky juice in many plants, which flows from them when their tissues are wounded, is a fact that has been familiarly known from time immemorial. It is however only a matter of recent discovery that this milky juice characterises certain families of plants. Although the great majority of plants which yield this juice in abundance are tropical, yet they are not without their European representatives. The Spurges, Dandelion, and Celandine of our road-sides are instances. The families of plants which furnish this milky juice in the greatest abundance are—*Moraceae*, *Euphorbiaceae*, *Artoca paceae*, *Apocynaceae*, *Cichoraceae*, *Papaveraceae*, *Companulaceae* and *Lebeliaceae*.

This juice, which is called by botanists 'the milky juice,' because it has an appearance similar to milk, has also the physical constitution of that fluid. It is an aqueous liquid, charged with soluble matter in which float globules of a substance insoluble in water, and which are by their tenuity held in suspension in the liquid, but for which they have no affinity, in the same manner as butter is held in suspension by milk. From the difference of the refractive powers of these two substances, each of which taken separately would be colourless or transparent, arise the opacity and white colour of the two: hence the compound is properly called a 'milky juice.'

The analogies which this juice exhibits with the milk of animals and vegetable emulsions are seen in the manner in which it acts when left to itself. Run out into the air, received and preserved in close vessels, it separates itself into two layers, as milk itself would do. The watery part very soon has an insoluble part floating upon it, which collects together and swims at the top as cream swims upon milk, and which forms nearly the half of the entire mass. But with these physical resemblances the analogies cease. That which in milk and in emulsions produced from seeds collects on the surface of the aqueous liquor is, properly speaking, a fatty body, containing oxygen in its composition; while the kind of cream which swims upon the milky juice is a compound of carbon and hydrogen.

This substance has long been known to the natives of both the Old and New World, in Hindustan and South America. It was not however till the expedition of the French academicians to South America in 1735 that its properties and nature were made known in Europe by a memoir upon it by M. de la Condamine. This notice excited little attention; and subsequently notices of this substance were sent to the French Academy in 1751 by M. Fresnau, and in 1768 by M. Macquer. At the letter end of the last century and the beginning of the present it was brought into this country in small quantities, where, on account of its being used for rubbing out black lead pencil marks, it acquired the name of India-rubber.

Although after its application to the water-proofing of garments its consumption gradually increased, the importation into the United Kingdom in 1830 appears not to have been more than 50,000 lbs. In 1842 the import of this article had increased to between 700,000 and 800,000 lbs. Up to the present time the consumption of India-rubber has prodigiously increased; and one part alone in South America is said now to send to Great Britain nearly 4,000 cwts. annually. To the large consumption in the United Kingdom must be added that of America, where the application of Caoutchouc has been much more general and successful than even in our own country.

The particular species of plants which are employed for procuring India-rubber are very numerous, and it is probable that many yield it which are not yet known to botanists. The tree which supplies most in Continental India is the *Ficus elastica*, a tree belonging to the order *Moraceae*; it is exceedingly abundant in Assam. All the species of *Ficus* yield Caoutchouc to a greater or less extent in their juices, and even the Common Fig (*Ficus Carica*) of Europe contains it. Species of *Ficus* produce the Caoutchouc brought from Java; and *F. radula*, *F. elliptica*, and *F. prinoides* are amongst those mentioned as affording a portion of that brought from America. Next to the *Moraceae* the order *Euphorbaceae* yields the largest quantity of Caoutchouc. The *Siphonia elastica*, a plant found in Guyana, Brazil, and extending over a large district of Central America, yields the best kinds of India-rubber that are brought into the markets of Europe and America. To another order, *Apocynaceae*, we are indebted for the Caoutchouc which is brought from the islands of the Indian Archipelago. The plant which is the source of this substance in those districts is the *Urceola elastica*, a climbing plant of very rapid growth and gigantic dimensions. A single tree is said to yield, by tapping, from 50 to 60 lbs. annually. Many other plants of this order yield Caouthouc, and of those given on good authority we may mention—*Collophora utilis* and *Cameraria latifolia*, plants of South America; *Vahea gummifera* in Madagascar; and *Willughbeia edulis*, in the East Indies. To this order belongs the Cow-Tree, or Hya-Hya (*Tabernæ-montana utilis*), of Tropical America, which yields a milky juice that is drunk by the natives of the district in which it grows.

The Caoutchouc, whilst it is in the tissues of the plant, is evidently in a fluid condition; but after its separation from the other fluid parts its consistence becomes changed, and it forms a solid mass similar in its external characters to vegetable albumen. In this state it is dense and hard, but may be separated and rolled out so as to form a sheet resembling leather. It has many interesting and peculiar properties. Insoluble in water and in alcohol, it dissolves in ether, in the sulphuret of carbon, the fat oils, and the liquid carburets of hydrogen.

It is soft and elastic at the ordinary temperature, but at the temperature of 2° above the freezing point it acquires the hardness of wood. A temperature of 100° softens it without altering its form. It then unites with itself with the greatest facility, and two pieces recently cut apart re-unite so as to render it impossible to discover where the junction has taken place. But a higher temperature, approaching 150°, changes it into an adhesive substance, which on cooling does not recover the primitive properties of Caoutchouc.

In the state of recent coagulation, and while still in a pulpy condition, Caoutchouc possesses a degree of plasticity which admits of its receiving, by means of moulds, the most varied forms.

The greater part of the Caoutchouc of commerce is obtained by the natives of the countries in which it is produced in the form of shapeless masses, collected at the foot of the tree which has been incised or cut for the purpose of extracting the juice from it, or solidified in a trench made in the earth, and coagulated in this rude mould in voluminous masses, which often resemble the trunk of a large tree. A part of it however possesses other forms which the rude art of the natives attempts to communicate to it. They model with plastic clay figures of animals, imitations of the human foot, and pear-shaped bodies; and then dipping these moulds in the thickened Caoutchouc, and renewing the connection when the first coat is solidified hy exposure to the air, they obtain, by breaking the mould and getting it out in fragments through an opening properly arranged, hollow flasks, figures of animals, rough slippers, &c. They thus make Caoutchouc serve for the manufacture of objects for which we ourselves employ animal membranes and leather.

India-rubber is obtained from both the Old and New World. The East Indies supplied ,the original specimens seen in Europe, and have ever since been a source of supply to the British markets. It comes principally from Java, and is often glutinous, and is less esteemed in Commerce than that furnished by the equatorial regions of America. Great quantities of Caoutchouc are imported into Europe from Mexico, from South America, and especially from the province of Para in Brazil. That which comes in the shape of bottles is generally preferred; and when it is pure, and the different coats which comprise it are well united, it may be employed immediately for many purposes. But it often happens that the coats which form the pear-shaped masses are badly united. It then becomes necessary, in order to make use of them, to work it up by a process of kneading, so as to obtain it in a coherent or homogeneous mass. This operation becomes especially indispensable when, as most commonly happens, the Caoutchouc is in large impure masses, and mixed with sand and the débris of vegetable matter. These impurities do not entirely proceed from the moulds made in the earth into which the juice has been allowed to exude, and in which it has been left to thicken and solidify; but their quantity and their presence between the coats of the pyriform masses show that the impurity is mainly to be attributed to fraud. The Caoutchouc thus obtained is not applicable to any use until it has undergone a previous purification.

The purification of the Caoutchouc is accomplished by submitting the impure Caoutchouc to the action of cylinders furnished with teeth turning in opposite directions and with unequal velocities, which cause it to undergo a kind of mastication. By this treatment the Caoutchouc becomes softened without being liquified, and a homogeneous mass is formed which is cut in the form of rectangular blocks, which being again cut, constitute those small parellelopipedons used by draughtsmen to rub out the marks of black-lead pencils. This use was in England for a long time the only one to which this substance was applied, but this limited use was far from indicating the extent to which Caoutchouc has been employed in the last thirty years, or the multiplicity of services it has been called upon to perform for sanitary and industrial purposes. To rub out pencil-marks, to form the rude slippers which seemed well adapted to the Indian toilet, but to which a form acceptable in Europe had not been imparted, were in fact the only uses to which Caoutchouc was applied up to 1820. [CAOUTCHOUC MANUFACTURE OF, in ARTS AND SC. DIV.]

The relations of Caoutchouc to the functions of the plants in which it is found are not understood. Many fallacious views have been offered on this subject. Schulze of Berlin, who has written most extensively on this subject,

regarded it as a principle in the juices of plants analogous to the fibrine of the blood, but his views with regard to the milky juice of plants and the laticiferous tissue are now generally allowed to be erroneous. It is not improbable that Caoutchouc is formed as the result of the deoxidation of cellulose, or some other ternary constituent. The chemical composition of Caoutchouc is Hydrogen and Carbon. In what proportion they exist is not known. When distilled, Caoutchouc yields oils which have a composition similar to oil of turpentine—C_5H_4 or $C_{10}H_8$.

(From *Lindley's " Vegetable Kingdom."*)

Caoutchouc is furnished by many of this Order (Moraceæ) in great abundance; all the India-rubber of continental India is obtained from Ficus elastica; in Java, other species yield this substance of excellent quality, as do F. Radula, elliptica, and prinoides in America. Their milky fluid is in some instances bland, and actually employed as a beverage; for of the different plants which have been occasionally brought to Europe under the name of Cow-trees, most are Figs.

The juice of Siphonia elastica, a tree inhabiting Guayana and Brazil, yields the bottle India Rubber, which is known in Europe; in preparing it the natives smear clay moulds with repeated layers of the juice, at the same time drying it in smoke. Aleurites triloba, whose seeds will be mentioned presently, exudes a gummy substance which the natives of Tahiti chew; A. laccifera furnishes gum lac in Ceylon; and the secretions of certain Crotons, viz., Draco and sanguiferum, become a similar red substance in the tropical parts of America.

(From *Schleiden's Lectures—" The Plant."*)

In the inestimable gifts of Ceres, in the seeds of the various kinds of grain, there always occurs more or less of a substance which was formerly called gluten. Liebig* and Mulder have pointed out that this resembles a mixture of gelatine and animal fibrine. The earlier chemists discovered in the Pulses a substance, which from the family in which it was found, the *Leguminosae* was called legumine. We now know, from more recent researches, that this is in no way different from animal *caseine*. Legumine and gluten, or caseine and fibrine, possibly occur in small quantity in the cells of all plants.

A great number of plants, which principally belong to three great families, namely, the Spurges, the *Apocynaceae* (Juss), and the Nettle plants, are distinguished by a peculiar anatomical structure. In their bark, and also partly in their pith, we find a quantity of long, variously curved and branched tubes, which are not unlike the veins of animals. Through this similarity, Professor Schultze, of Berlin, was led to develop a comprehensive theory of a circulation through these structures of the fluids contained in them, which he called vital juices, which theory, unhappily, cautious science was compelled immediately upon its promulgation, which made so great a show, that it appeared as one of treaties honoured by the Paris Academy with the Monthyon prize, to demonstrate to be a mere brain-spun phantom. In these tubes we find a thick juice of the consistence of very rich milk, whence it is called milk-sap. Its colour is usually milk-white, but yellow, red and very rarely, blue milk-saps are met with, but more frequently still they are wholly colourless. Like animal milk this juice consists of a colourless fluid and small globules. The composition displays the most varied constituents, and upon the variation of quantity and modes of mixture of these matters, depend the abundant varieties of this juice. All contain more or less *Caoutchouc*, which occurs in the form of little globules. These are prevented from coalescing by an albuminous substance, in the same way as are the butter globules in milk. Exactly like the cream (the butter) in milk,

* See Liebig, "Chemistry and Physics in relation to Physiology and Pathology," 8vo. London, 1847.

the Caoutchouc globules rise to the surface of the milk-sap of plants when left to stand, here form a cream and coalesce, and cannot any more than butter, be separated again into their distinct globules.

All those three great families which are distinguished by their abundance of milk-sap, although differing very widely botanically, exhibit some most remarkable agreements through the nature of their milk-sap.

It will not be uninteresting to give a more detailed account of these three families, and to mention the more important plants belonging to them.

The Spurges of *Euphorbiaceæ* constitute the most important group in reference to the amount of Caoutchouc contained. From the Port of Para in South America, from Guiana and the neighbouring States, an incredible quantity of India-rubber is shipped for Europe, and this is principally obtained from a large tree growing in those regions called the *Siphonia elastica*. In the year 1736, the celebrated French *savan*, La Condamine, first directed attention to Caoutchouc, and minutely described the mode of obtaining it. That beautiful tree, the *Siphonia*, is about sixty feet high, and has a smooth brownish-grey bark, in which the Indians make long and deep incisions down to the wood, from whence the white juice then abundantly flows forth. Before it has time to dry, it is spread upon moulds of unburnt clay, usually of the shape of a small, roundish,, short-necked bottle, and then dried over a smoking fire. The spreading of the Caoutchouc upon the mould is repeated until the coat has acquired the desired thickness. By this operation, in which the foreign matters are not separated from the juice, which becomes still more contaminated by the smoke, the Caoutchouc acquires a brown or black colour, while pure Caoutchouc is white, or of a yellowish colour, and semi-transparent.

We owe a subsequent more accurate knowledge of the tree and its distribution, to Fresneau, in the year 1751; but especially to the indefatigable naturalist, Aublet du Petit-Thouars.

Many other plants of this group contain Caoutchouc, but from none is it so easy to obtain it in large quantity. Though the sap of *Siphonia* is at least harmless, though the juice of the *Tabayba dolce (Euphorbia balsamifera*, Ait) is even similar to sweet milk and, thickened into a jelly, eaten as a delicacy by the inhabitants of the Canary Islands, as Leopold von Buch relates in his interesting description of the Canaries; yet most of the plants of this group are to be counted among the suspicious, of even most actively poisonous, on account of this very juice. And yet, strangely enough, they also furnish a most wholesome food, which we have scarcely anything to compare with. Throughout all the hotter part of America, the culture of the Mandioc-root *(Jatropha Manihot)* is one of the most important branches of husbandry. The native savages and the Europeans, the black slave and free man of colour, alike substitute for our white bread and rice, the *Tapioca* and the *Mandioca farinha*, or Cassava-meal, and the cakes prepared from it *(pan de tierra caliente* of the Mexicans*)*; which are obtained from that most poisonous plant. The sweet Yucca *(Ajuca dulce)*, which is the name applied there to the Mandioca plant, must be distingushed from the sour or bitter kind *(Yuca amara)*. The former, which is therefore cultivated with great care, may be eaten at once, without danger; while the latter, eaten fresh, is an active poison. They serve the uncivilized son of the South American tropics for food, and we will watch him for a moment in his haunt. In a dense forest of Guiana, the Indian chief has stretched his sloping mat between two high stems of the Magnolia, he rests indolently smoking beneath the shade of the broad-leaved Banana, gazing at the doings of his family around. His wife pounds the gathered Mandioca-roots with a wooden club, in the hollowed trunk of a tree, and wraps the thick pulp in a compact net made from the tough leaves of the great Lily-plants. The long bundle is hung upon a stick, which rests on two forks, and a heavy stone is fastened to the bottom, the weight of which causes the juice to be pressed out. This runs into a shell of the Calabash gourd (*Crescentia Cujete*), placed

beneath. Close by squats a little boy, and dips his father's arrows in the deadly milk, while the wife lights a fire to dry the pressed roots, and by heat to drive off more completely the volatile poisonous matter. Next, it is powdered between two stones, and the Cassava-meal is ready. Meanwhile, the boy has completed his evil task; the sap, after standing some considerable time, has deposited a delicate, white starch, from which the poisonous fluid is poured off. The meal is then well washed with water, and is the fine white Tapioca, resembling, in every respect, Arrow-root. In a similar, more or less skilful manner, are the Mandioca and Tapioca, everywhere prepared. The sated stavage saunters round to seek a new sleeping-place, but woe to him! inadverten y he has prepared his couch beneath the dreadful Manchineel (*Hippomane Mancinea*), and in a sudden shower, the rain drips from its leaves upon him. In frightful pain he wakes up, covered with blisters and ulcers, and if he escape with life, he is at least the richer of a fearful experience of the poisonous properties of the (*Euphorbiaceæ*). But this will seldom happen to a native; the Manchineel is avoided in America with the same mysterious and almost superstitious awe, as the fabulous Poison-tree in Java. Happily, the Trumpet-tree (*Bignonia leucoxylon*), the sap of which is the surest antidote against the Manchineel, usually rears its beautiful purple blossoms close at hand, the constant companion of that dangerous Euphorbiaceaen.

The planter of the Cape strews over pieces of flesh the pounded fruit of a plant that grows there (*Hyænanche globosa*, Lam.), and lays them as an infallible poison for the Hyæna. The wild inhabitants of southern Africa, according to Bruce, poison their arrows with a Spurge (*Euphorbia caput Medusae*). Virey states, that the Ethiopians make a similar application of others (*Euphorbia heptagona*, *E. virosa* W., *E. cereiformis*), while the savages of the most southern part of America use the sap of a third (*E. cotinifolia*). Nay, even our seemingly so innocent Box, which also belongs' to this family, is so injurious, that in places in Persia, where it much abounds, no camels can be kept, because it is impossible to prevent their feeding on this plant, which is deadly to them. I cannot take leave of this family without mentioning a remarkable phenomenon reported to us by Martius, in that work so full of information, his Travels through Brazil. A Spurge grows there (*E. phosphorea*, Mart.) the milk of which, when it flows forth from the stem in the dark, hot summer nights, emits a bright phosphoric light.

While the family just alluded to, the blossoms being generally insignificant, attract the attention of our horticulturists almost solely through their strange forms, which, in some of them, approach to those of the Cactus plants—the family of the *Apocynacae* is, on the contrary, a rich ornament of our gardens and hot houses, on account of the wonderful beauty of its blossoms, and is often still more attractive from the remarkable structure of the flowers, and the aberrant, also Cactus-like form of the plant itself. What lover of flowers knows not the splendid blossom of the species of *Carissa*, *Allamanda*, *Thevetia*, *Cerbera*, *Plumieria*, *Vinca*, *Nerium* and *Gelseminum*—the strange stalk and toad-coloured, ill-smelling flowers of *Stapelia*? But this family is not less interesting in other respects. The best Caoutchouc at present known, that from Pulo Penang, comes from a plant of this family (*Cynanchum ovalifolium*). Also that from Sumatra (*Urceola elastica*, Roxb.), from Madagascar (*Vahea gummifera*. Poir), a part of the Brazilian (*Collophora utilis*. Mart. and *Hancornia speciosa* Mart.), and the East Indian (*Willughbeia edulis*), are obtained from plants which belong to the group of *Apocynaceæ*.

Most strangely, this family also, as well as the following and last, exhibits the peculiar phenomenon which was described in the first-named, the *Euphorbiaceæ*; namely, that the milk-sap is in some species rich in Indian rubber, in others, it is tempered into a clear, agreeably smelling, and wholesome milk, while in certain others, on the contrary, this fluid grows, step by step, through successively increasing quantity of noxious matter, to a most dreadful poison. In the forests of British Guiana grows a tree which the natives call Hya-Hya (*Tabernaemontana utilis*,

Arn). Its bark and pith are so rich in milk that an only moderate-sized stem which Arnott and his companions felled on the bank of a large forest-brook, in the course of an hour coloured the water quite white and milky. This milk is perfectly harmless, of a pleasant flavour, and is taken by the savages as a refreshing drink. Still more pleasant must be the taste of the milk of the Ceylon Cow-tree, the Kirianguna (*Gymneura lactiferum*, Roxb. Br.), which, according to Burmann's narrative, the Sinhalese use exactly as we do milk.*

CAOUTCHOUC CULTIVATION IN BRITISH INDIA.

(From *Clements Markham's Peruvian Bark* pp. 441-466.)

In 1870 I came to the conclusion that it was necessary to do for the india-rubber or caoutchouc-yielding trees what had already been done with such happy results for the chinchona trees. The area of yield of caoutchouc is far more extensive than that of febrifuge alkaloids only grow wild on the slopes of the Andes, and all belong to one genus, the caoutchouc-yielding trees are of several genera, and are found in the forests of India, the Eastern Archipelago, Africa, Madagascar, Mexico, and Nicaragua, as well as in South America. But the same danger threatens the one product as had threatened the other. Owing to the enormous demand for caoutchonc, the most reckless felling is now going on in all the tropical forests which yield this valuable product. The time has come when plantations must be formed of caoutchouc-yielding trees, in order to prevent their eventual destruction, and to provide for a permanent supply.

The increase in the demand for india-rubber is very remarkable, and the enormous number of uses to which this product is now put, renders the consideration of measures for its cultivation, and for securing the permanency of an adequate supply, a question of great moment. In 1830 only 464 cwt. of india-rubber were imported into this country. In 1840 the quantity had increased to 6640 cwt.; and in 1846 the duty on india-rubber of 1*s*. per cwt. was repealed. In 1857 the quantity had further increased to 22,000 cwt; and in 1874 there were 129,163 cwt. imported into this country, worth £1,326,605. In 1878 the quantity imported into England was 149,724 cwt., worth £1,313,209. Caoutchouc is now used for an infinite number of purposes. Wherever steam-power is employed, either on shore or afloat, it is impossible to do without india-rubber. It is required as packing for the piston-rods and glands of the engines, valves for the pumps, washers for making joints, belting for driving the shafting, hose and tubing for conveying steam and water, buffer-spring for railway carriages, and many other such purposes too numerous to mention. When it is considered that every steam vessel afloat, every railway train, and every factory on shore employing steam-power, must of necessity use india-rubber, it is hardly possible to overrate the importance of securing a permanent supply, in connection with the industry of the world.

For purposes connected with telegraphy this product is also now extensively used. It is employed as the insulating material for submarine, subterranean, and aërial cables. In the hard form of ebonite it is employed for insulators to carry the iron wire along the posts, as well as for battery cells, for the electro-magnetic coils, and in many parts of telegraphic intruments in place of the more expensive article, ivory. India-rubber is also used for waterproof clothing, carriage aprons, fishing stockings, diving dresses, water and air beds and cushions, door mats, ground sheets in camping out, and tubing. India-rubber elastic thread is largely used in the form of webbing, by the Leicester, Derby, and Nottingham manufacturers. India-rubber is necessary, too, for life saving

* But this is not stated by Hermann, and Burmann, who first described the plant. Their discussions were misunderstood.

apparatus, for surgical instruments and appliances, and for hose, gas-tubing, and innumerable domestic purposes, including door-springs, and just now, a great many rings for the rinking skates. Ebonite—which is the form of india-rubber vulcanized hard by the addition of extra sulphur, so that it can be turned in a lathe and made into articles of any form or shape—is used very extensiveley for combs, photographic baths and trays, syringes, taps and tubing for aquaria, and in chemical works.

Such being the infinity of purposes which give rise to the demand, it will easily be understood how bravely the work of destruction is being carried on. In British India there is an indigenous caoutchouc-yielding tree, which should be brought under cultivation on the spot. But there are other kinds in other parts of the world, and it became necessary, in the first place, to ascertain whether they are superior to the caoutchouc in British India; for, if so, their introduction would needs be an essential part of any scheme for initiating the cultivation.

The caoutchouc-yielding trees grow in a zone on each side of the equator, encircling the globe, but by far the richest and best source of supply is in South America. It was M. de la Condamine, the leader of the expedition to measure an arc of the meridian near Quito, who first gave an accurate description of caoutchouc, and of the tree from which it is procured. The tree is the *Siphonia* or *Hevea*, which grows in all parts of the basin of the Amazon, and yields the Brazilian caoutchouc. This is the best and most abundant, and is known as Para india-rubber. The *Hevea* is a euphorbiaceous tree.

On the Western side of the equatorial region of South America, in Ecuador and Colombia, on the isthmus of Panama, Central America, and Mexico, the india-rubber tree belongs to the *Castilloa* genus, so named after Don Juan del Castillo, a Spanish botanist, who died in Mexico in 1793. The native name of the tree in Mexico is *ulé*. The *Castilloas* belong to the family of *Artocarpaceæ*, of which the bread fruit and jack tree, and the *anjeli* of India, are members. It is worthy of note that the *Artocarpaceæ* are closely allied to the *Moraceæ*, the fig tribe, to which the caoutchouc trees of India belong. The *Heveas* and *Castilloas* are the india-rubber trees of the New World.

In India the *Ficus elastica*, a tree so named by Dr. Roxburgh in 1810, which yields caoutchouc, is found in the forests which border the valley of the Brahmaputra, in the province of Assam. The family of *Apocynaceæ* includes the other caoutchouc-yielding trees of Asia and the eastern islands the *Chavannesia* of British Burma, the *Urceola* of Borneo, and the *Vahea* of Madagascar, as well as the *Landolphias*, which produce the caoutchouc of Africa.

In commencing caoutchouc cultivation in India, it was in the first place necessary to take stock of all existing knowledge on the subject, and in the second place to ascertain whether any of the other kinds were intrinsically superior to the *Ficus elastica*, because if this proved to be the case, their cultivation in India would also be desirable.

With these objects in view, I intrusted the duty of making the necessary researches and investigations to Mr. J. Collins formerly curator of the Museum of the Pharmaceutical Society, who drew up a very able and exhaustive report on the subject in 1872. The conclusions then arrived at were that the establishment of plantations of *Ficus elastica* should at once be undertaken in Assam; but that the caoutchouc from the *Heveas* and *Castilloas* of South America was superior to that of the *Ficus*, and that consequently those trees should be introduced into British India.

The first step, therefore, was to commence the cultivation of the native Indian caoutchouc tree, which is found in the forests along the northern and eastern boundaries of Assam, as well as in the low valleys of the Naga and Jaintia hills to the south. The *Ficus elastica*, like the banyan and other trees of the same genus, has aërial roots, and is of an epiphytical habit. When wild in the forests it often commences its growth in the fork of another tree, which it eventually overshadows and destroys. It grows to a great size, and

one tree planted at Tezpur in Assam, 36 years ago, is 112 feet high, the diameter of the crown measures 140 feet, the circumference of the central mass of aërial roots surrounding the stem is 70 feet, and it has over a hundred aërial roots the largest of which measures six feet in girth. The forests containing *Ficus elastica* are excessively moist in the rainy season, and they remain moist all through the dry season with a temperature of about 98° in the shade. The trees thrive best under conditions of excessive moisture and great heat, but with good drainage.

Hitherto the caoutchouc has been collected in Assam by men of the wild tribes, who cut every part of the tree they can get at, and allow the milk to flow into holes made in the ground. The collectors are encouraged to obtain the largest possible quantity during the shortest possible time, without any regard to future supplies. This has led to the most outrageous wholesale destruction of these valuable trees, by felling them so as to render the operation of tapping more convenient. Messrs. Martin and Richie, who had a lease of the caoutchouc yield at Tezpur, are said to have given it up before their time expired, because the supply had diminished so much that their business was no longer remunerative.

So that no improvement of the yield can be expected from private enterprise, except at the risk of exhausting the remaining sources of supply; and it is consequently necessary to place the collection of caoutchouc in Assam under the control of public officers who have an interest in the protection and improvement of the forests; and to commence the formation of plantations of *Ficus elastica* on a large scale, and in accordance with a well-considered plan. Dr. Brandis, Inspector-General of Forests in India, strongly urged the necessity of these measures in 1872; and good progress has since been made, under the superintendence of Mr. Gustav Mann, the conservator of Forests in Assam.

The first attempts, which were started in July 1873 in the Darjiling Terai and in the Goalpara district of Assam, were failures, but in July 1874 Mr. Gustav Mann took charge of the experiment with very satisfactory results. Three plantations have been formed. One, on the right bank of the river Kulsi, in the Kamrup district of Assam, consisted of 95 acres in 1879, on which were 2,895 plants. Another is at Charduar, at the foot of the Himalayas, 18 miles north of Tezpur, in the Darrang district of Assam, where there were 685 acres under cultivation in 1879, the growth of the trees being excellent and most vigorous. The third plantation is at Bamuni, also near Tezpur. Here, there were 8 acres planted with 459 trees in 1878; but the climate is too dry. No artificial shade is now given, and the young trees are healthy and vigorous. Experiments are in course of trial, to plant the *Ficus elastica* in strongly made baskets placed in the forks of trees, and on grass lands, as well as in the regularly prepared beds The trees may be tapped at the age of 25 years. After 50 years they will yield 40 lbs. of caoutchouc every third year, worth £3 4*s*. In Cachar the india-rubber tree was discovered in 1862, and 750 cwt. were collected, the yield being increased to 1,500 cwt. In 1863. The yield from the first tapping is 35 to 40 lbs. The tree is then untouched for three or four years, and second tapping yields much less. Mr. Edgar reports that the Cachar forests would yield 2,000 cwt. annually. In 1879, the quantity of caoutchouc exported from India was 10,033, cwt. valued at about £61,685.* Besides extending the cultivation of the trees, the officers in charge of the plantations will carefully investigate all such questions as the most favourable time of the year

* Caoutchouc exported from British India during six years and past three seasons:—

1874—16,837	cwt.	valued at	£117,775	1883-4 = R1,133,586
1875—19,893	„	„	£108,618	1884-5 = R773,289
1876—15,258	„	„	£97,861	1885-6 = R656,204
1877—13,308	„	„	£90,169	
1878—13,794	„	„	£89,381	
1879—10,033	„	„	£61,685	

for tapping, and the best methods for collecting and preparing the caoutchouc. The experimental cultivation of the *Ficus elastica*, has thus been satisfactorily commenced in India, under the able superintendence of Mr. Gustav Mann.

Another caoutchouc-yielding plant belonging to the *Apocynaceae* has recently been discovered in British Burma, and reported upon by Mr Strettell of the Forest Department. It is the *Chavannesia esculenta*, a creeper which it has hitherto been the object of foresters to extirpate, as injuring the growth of teak trees. Some of these creepers, growing near Rangoon, have a girth of 18 inches round the stem, while the crown covers an area of 200 square feet, at a supposed age of five years. It may be propagated either from seeds or cuttings; and instructions for its cultivation have recently been published in the *Indian Agriculturist*. The estimated result of cultivating trees 30 feet apart over an area of 400 acres, or in all, 19,200 creepers, is that there will be an annual yield of 19,200 *viss* (a *viss* is about 3½ lbs.), which at R200 per 100 *viss*, will give R38,400 a year. After the first year, the cost of cultivation will be very slight, and the profits will begin to come in after seven years.

As regards the cultivation of indigenous kinds of caoutchouc-yielding trees in British India, it will thus be seen that the initiatory steps have already been taken. The second, and not the least important part of the undertaking, is the introduction of plants yielding a better kind of caoutchouc, from other parts of the world, but especially from South America.

The most valuable trees, and those which now yield by far the largest quantity of india-rubber, are the *Heveas* of the Amazon valley, called Para from the port of shipment. We learn from Keller that, during the last few years, both the quantity and the value of india-rubber exported from Para have been steadily increasing. In 1874 England received 56,580 cwts. of Brazilian caoutchouc, £720,000; the average price being 2*s*. 6*d*. to 3*s*. a lb. Next to the Para rubber in value and yield, comes that obtained from the *Castilloa* trees, which grow over a much wider area of South and Central America. The quantity of *ule* or *Castilloa* caoutchouc imported into England in 1874 was 24,286 cwts., worth £287,413, at 2*s*. a lb. Thus out of the whole import of 129,263 cwts., 70,866 come from South America.

The remaining 38,775 cwts. are divided among British India, Borneo (1*s*. 9*d*. a lb), Africa (1*s*. 5*d*. a lb.), and Madagascar (2*s*. 3*d*. a lb.) But the South American source of supply is, beyond comparison, the most valuable, and the cultivation of *Castilloa* and *Hevea* trees in India is an important part of the undertaking.

Several reasons led me to the decision that a collection of the *Castilloa* seeds should first be obtained. As the *Castilloas* grow over a much more extensive area than the *Heveas*, where there is a greater variety of soil and climate, it is more certain that suitable sites for their cultivation would be found in India and Burma. They belong, too, to the *Artocarpaceæ* which are so well represented in India, especially on the Malabar and Travancore coasts, by the jak trees, and the *anjeli*, of which wood all the canoes are built.

The *Castilloa* trees flourish in all the equatorial forests on the west coast of South America, and 1878 the quantity of india-rubber exported from Guayaquil was 6,561 cwts., worth £22,963.* The trees also abound all over the isthmus of Darien, where they are being destroyed most recklessly, in Central America,† and in the southern states of Mexico. In Ecuador the india-rubber is called *heve*; in Mexico and Central America the Aztec word *ule* is used.

The trees, which are the giants of equatorial American forests belong to two species, the *Castilloa elastica*, and that which Mr. Collins has named *Castilloa*

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* This shows a large falling off. In 1873 it was 16,635 quintals, and in 1874, 10,690 quintals. In 1876 it again rose to 10,138.

† From San Jose de Costa Rica, 78231 lbs. of india-rubber were exported id 1878. The quantity is not given for Guatemala, but the value is stated as $ 1,540 in 1878.

Markhamiana. They thrive in dense steaming and warm forests, and are particularly abundant in the valley of the San Juan de Nicaragua, where it rains for nine months in the year. In Nicaragua the yield is said to be about 10,000 cwts., giving employment to 600 *huleros* or collectors. From Carthagena, Guyaquil, Panama, and Vera Cruz, are exported supplies of *ule* india-rubber, the greater part of which goes to the United States; but it has been seen that as many as 24,286 cwts. arrive in this country.

The collection of *Castilloa* plants for introduction into India was a very difficult service, for the trees grow in wild and unhealthy forests, with no means of transit, and no facilities of any kind. In Mr. Cross I found a man with all the requisite qualifictions for undertaking it. He is an excellent gardener, possessed of great energy and determinaiton, combined with judgments, is acquainted with the language, and has had much experience in South American travelling. No better man could be found to execute the difficult task of obtaining a supply of *Castilloa* plants, and conveying them in a healthy state from their native forests to the gardens at Kew.

Mr. Robert Cross left England on the 2nd of May, 1875, and reached Panama on the 26th of the same month, my instructions to him being to endeavour to make the collection on the isthmus. He found that great destruction was going on among the *ule* trees in all parts of the Darien isthmus, the native collectors cutting down the trees in order to tap them more easily, as is the case in the Assam forests. After obtaining all the information that could be procured in Panama, Mr. Cross determined to select the forests on the banks of the large tributaries of the river Chagres as the base of his operations.

He ascended the Chagres river in a canoe, and then made a journey on foot through the dense forest, into the heart of the *ule* district. He found the *Castilloa* saplings growing on the banks of streams, with their roots often running down to the edge of the water. They abound in rich soil along the base of the hills, and are also met with on the summits of ridges; everywhere, except in swampy ground. The trees, which proved to be of the species named by Mr. Collins *Castilloa Markhamiana,* are from 160 to 180 feet high, with a diameter of 5 feet, and a yield of 100 lbs. of india-rubber. The wood is spongy and soft, and decays rapidly when bruised or injured. Many of the leaves measure fourteen inches in length, and seven inches in breath. The temperature of the forests ranges from 75° to 80° Fahr., and they are excessively damp. The range of the *Castilloas* is so wide that, in some places, the trees must flourish in climates which at one time of the year are dry. It is probable, however, that the species with the best and largest yield of caoutchouc flourish best in a hot and very damp and steaming atmosphere, like that of the forests of the isthmus.

Mr. Cross collected 600 plants, and also drew a quantity of milk, in order to prepare a specimen of the rubber. The sample he brought home was examined and reported upon, and was pronounced to have much less impurity than is usual for this kind of rubber, and thus proved Mr Cross's plants to be of the best species. He left the isthmus with the plants on the 6th of September 1875, on board the mail steamer *Shannon,* but in the morning of the 8th, when going 13 knots an hour, the vessel ran on the Pedro reef of rocks, off the coast of Jamaica, and her bows were immovably fixed upon them, while the stern continued to bump heavily for many hours. The rest of the passengers left the ship in boats, but Mr. Cross stuck manfully by his plants and was eventually taken on board H. M. S. *Dryad.* He came home in the mail steamer *Nile,* reaching Southampton on the 2nd of October. Considering all the extraordinary difficulties of the undertaking, it reflects great credit on Mr. Cross that he should have been successful, and thus have performed an important public service with ability and sound judgment. There were soon 134 of Mr. Cross's *Castilloa* plants in a flourishing condition at Kew Gardens, and

in the course of 1876 a good supply of *Castilloas* was forwarded to India, to form the nucleus of a series of plantations.

Thus the introduction of one out of the two valuable South American species was provided for.

It remained to take measures for obtaining plants of the most valuable kind of all from the valley of the Amazon—the *Hevea* yielding the famous Pará india-rubber of commerce.

The *Heveas* are of several species, and, like the *Castilloas*, they are large trees growing in humid tropical forests. Dr. Spruce, who is the highest authority on this genus, considers that the Cordilleras of the Andes separate the *Castilloas* from the *Heveas*, and that the caoutchouc-yielding trees to the eastward of the Andes are of the latter genus. They extend up to the very foot of the mountains, and I have myself passed some time among *heveros*, collecting for local use in the *montanas* of Paucartampu and Laris. While in Peru and Ecuador the india-rubber is called *heve*, in Brazil the name is *seringa*, and the collectors are *seringueiros*. Eight species are enumerated by Collins, namely:—

Hevea Brasiliensis	(Mull.)	*Hevea Rigidifolia*	(Mull.)
„ *Spruceana*	(Mull.)	„ *Benthamiana*	(Mull,)
„ *Discolor*	(Mull.)	„ *Lutea*	(Mull.)
„ *Pauciflora*	(Mull.)	„ *Guyanensis*	(Aube.)

The *Hevea Brasiliensis* is the species which prevails round Pará and the forests of the lower Amazon; *H. Spruceana* is met with round the mouth of the Tapajos, and the other species occur on the banks of the Rio Negro and Casiquiari; but the genus is far from having yet been thoroughly studied.

In the Pará district of the lower Amazon very little rain falls from August to February, the heaviest rains being in May and June; and the temperature varies between 74° and 95° Fahr.; the mean of a year being 81°. The Amazon valley is remarkable for uniformity of temperature, and for regular supply of moisture; the dry season extending from June to December, and the wet from January to May. In the Upper Amazon the atmosphere is densely vaporous.

Our latest authorities on the Pará caoutchouc are Mr. Wickham and Mr. Franz Keller. The latter traveller, writing in 1874, says that the *hevea* trees on the shores of the Amazon have nearly disappeared, owing to the destruction and death of trees, the places of which have never been filled up. But the forests of caoutchouc-trees on the banks of the Madeira, Purus, and other tributaries, yield over 1,600,000 lbs; while the yield of the whole of this colossal river basin amounts to 12,800,000.* Keller laments the fact that no attempt is made, in the Amazon district, to cultivate these useful trees; which, owing to frequent tapping and rough treatment, suffer much and die soon. The *seringueiros* have to go farther and farther into the interior, to seek fresh trees in undiscovered valleys. It is to be feared that, owing to the indolence of the mestizo population, and the short-sightedness of the Brazilian Government, measures of conservancy will not be adopted until too late.

The *Castilloa*, like the *Ficus elastica*, though requiring a very humid climate, will only thrive when there is drainage at the roots, but Keller says that the *Hevea* yields the largest supply of milk when, during the annual inundation, its stem is at least five feet under water.

The scene presented by an encampment of caoutchouc collectors is extremely picturesque. Their huts are lightly built among the trees, and round them tower the majestic *mosqueteiro* palms, and the lofty *Bertholletia*,† while in front

* Keller gives the following statement of the export of caoutchouc from Parà:—

1865—256,967 arrobas.
1866—291,091 „
1867—301,170 „
1868—334,975 „
1869—365,354 „ (4558 tons.)

† *Bertholletia excelsa* yields the Brazilian nuts.

is the gleaming river with its sunny sandbanks. From the huts narrow paths lead through the dense undergrowth, cut by the axe of the *seringueiro*, to the lonely caoutchouc-trees. The collector makes small holes in the bark, to which tubes of clay are fixed, which lead the milk into bamboo receptacle; going from tree to tree he collects these bamboos, and on his return to the hut the contents are poured into the carapace of a large tortoise. The milk is then subjected to the process of smoking without delay, for if left standing too long the resin separates. In this process the milk is subjected to the smoke of the *urucuy* or nuts of the *Athola excelsa* palm, which alone, it is said, possesses the power of liquefying. An iron pot, without a bottom, and with a narrow neck like a bottle, is placed so as to form a chimney over a heap of these burning nuts, and the white steam rises in masses through the narrow opening. The *seringueiro* pours a small quantity of the white fluid, of the consistency of thick milk, from a calabash over a light wooden shovel, as evenly as possible, and then rapidly thrusts it into the white steam. The milk soon takes a greyish-yellow colour, and becomes firm. Then they add layer upon layer, until the caoutchouc on each side of the shovel is about 8 inches thick.

The *plancha* or slab is then finished, taken off the shovel by cutting down one side, and hung up in the sun to dry, as there is a good deal of water between the layers. The colour of the *plancha* is at first a light silver-grey, but by degrees becomes yellower and yellower, until it turns the dark colour known in commerce; a practised hand can, in this way, manufacture 5 or 6 lbs, in an hour. The thicker and freer from bubbles, the better the quality and the higher the price. The cheapest is called *surnamby* or *cabeza de negro* (negro-head), and is made from drops found at the foot of the trees and from the refuse in the vessels. The export of caoutchouc from Pará in 1876 amounted to 6493 tons, worth £955,000.

There are two other india-rubber trees of South America of less value, whence come the Pernambuco and Ceará rubbers. The Perambuco is an apocyneaceous tree, *Hencornia speciosa*, known as the *mangiaba* by the natives, and is found in the provinces of Rio de Janeiro, Bahia, Pernambuco, and Goyaz. It is a small tree about the size of the apple, and is more valued for its fruit than for its caoutchouc, which is not much collected. The Ceará tree (*Manihot Glaziovii*) is more important, especially as it flourishes in a dry climate.

For obtaining plants yielding the india-rubber of Pará and Ceará I was again so fortunate as to secure the services of Mr. Cross; who left Liverpool on June 19th, 1876, and reached Pará, at the mouth of the Amazons, on July 15th. He found, on inquiry, that the great field for caoutchouc collecting was the province of Pará, and the islands formed by the delta of the river, especially Marajo. The land round Pará rises from the bank of the river southward in gentle undulations, cut by the deep gully-like natural ditches called *gapos*, which often penetrate for many miles into the interior of the vast forest region, and are filled daily by the tide. To those navigable by canoes the term *ujarape* is often applied. The intervening land between the *gapos* owes its origin first to tidal deposits, and afterwards has been raised by the decayed remains of a long series of rank growths of vegetation. On the more elevated lands, beds of white sand 20 feet deep are met with, covered with a layer of decayed vegetation. In every direction the country is a mass of dense exuberant forest.

Mr. Cross explored this region, in order to make observations on the soil, climate, and mode of collecting and preparing the rubber. On the 2nd of August he was following the tracks of the rubber collectors through the dense forests ankle-deep in mud, until he came to a wide *gapo* into which the tide flowed. It was connected with many lesser watercourses, forming a kind of network over a whole district of forest, the most elevated parts of which were only raised three to four feet above the highest tides. India-rubber trees grew along the margins of the streams, and Mr. Cross observed three, the trunks of which were flooded to a height of a foot. Most of the others occu-

pied dry situations. The *gapos* are lined with soft rich mud, and the exhalations from such places, shrouded by a forest growth of 80 to 100 feet high, always produce attacks of fever. Mr. Cross measured a few of the largest trees, all of which had been tapped for periods varying from five to fifteen years, and found their circumference, one yard from the ground, to vary from 3 feet to 6 feet 10 inches. Regularly tapped trees do not exceed 60 feet in height.

Mr. Cross went on with the work of collecting plants, and established them at once in cases. In this way he made a collection of 1,000 plants in four cases. The range of the thermometer from July to October was from 72° to 92°. On the 17th of October, 1876, the collection was shipped for Liverpool, and Mr. Cross proceeded, in the same steamer, to the Ceará region. He landed in a heavy surf, on a kind of raft called *jangada*, and found himself in a very different country from that of the Amazon.

South of the Amazonian forest, there is a region known as *Sertao* or wilderness; extending in a broad belt from the Parnahyba river to the São Francisco. The province of Ceará is within this belt—a high rolling plain, broken by abrupt elevations and chains which are, in fact, outlying fragments of the great central table-land of Brazil. The only high forest is found on these mountain sides, the summits and the plains below being occupied either by thin forest growth, or by pastures and sandy tracts, with groves about the river cources. From June to December the climate is extremely dry, and the streams and rivers disappear, except along the mountain sides. The rains, at times very heavy, come in December and January. The principal commerce of the country is in hides and jerked beef; and there are plantations of sugar, coffee, and cotton, along the mountain sides. In 1877-78, Ceará was visited by a terrible drought and famine, when about half the population perished.

Ceará is connected with a place called Pacatuba, forty miles inland, by a railway made to facilitate the transport of sugar and cotton. It traverses a flat and parched country, covered with thickets of thorny bushes, and slender myrtles and *Leguminosae*. Here and there clumps of the *carnauba* palm (*Copernicia cerifera*) rise high above tbe other trees and bushes. The crowns of these palm-trees, waving with the wind, are visible over a wide expanse, and the back ground is formed by a range of mountains. Mr. Cross stopped at a village called Maracanahú, about 30 miles from Ceará, where he obtained a guide to take him to the india-rubber trees. The forest was tolerably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. Neither grass nor weeds grew under the trees, and there was an entire absence of ferns, mosses, and other plants. Mr. Cross concluded that Ceará rubber-tree would thrive perfectly over a very wide area of the drier regions of British India. At first sight the tree resembles a birch, and the outer bark comes off in the same way, in thin silvery peelings. The largest tree was about 50 feet in height, with the trunk about a foot in diameter. Having found some young plants, Mr. Cross had great difficulty in uprooting them. The roots have tubes the size of kidney potatoes which adhere with great tenacity to the soil. After diligent search and very severe labour eighteen plants were collected, and brought safely on board the steamer. Thus in one day Mr. Cross was able to discover the origin of a tree hitherto unknown and undescribed, yielding an important article of commerce, and at the same time to secure a number of plants. Next day he again went to Maracanahú, and obtained 42 more plants and 700 seeds.

Mr. Cross arrived at Liverpool on the 22nd of November, 1876, and his valuable collection of plants was deposited at Kew the next morning, consisting of a thousand plants of Pará rubber-trees (*Hevea Braziliensis*) and forty-two Ceará plants.

Thus all the valuable caoutchouc trees of South America had been obtained, and were ready for experimental cultivation in India; but Government was very lukewarm on the subject, and I considered it most safe to send them, in the first instance, to the Ceylon Gardens at Péradeniya. From that centre their cultivation could be extended to India hereafter, when its importance is

better appreciated by the authorities. The Ceará plants (*Manihot Glaziovii*) arrived from Kew in October 1877, and grow admirably in the Péradeniya and Henaratgoda gardens. They have produced ripe seeds; and plants have already been sent to Calcutta, Madras, Burma, and the hot districts of Ceylon, for trial. The *Hevea* also grows extremely well. A few trees are already nearly 30 feet high, with a girth of 14 inches. Already 500 *Hevea* plants, raised from cuttings, have been sent to Madras and Burma. The *castilloa* trees grow well at Péradeniya, still better at Henaratgoda. Some are 16 feet high, with a girth of 16 inches. The increasing demand for caoutchouc must eventually convince the Government of the great importance of its systematic cultivation. The Pará rubber is the best and choicest, the castilloa will grow over the largest area in the moist belts, and Ceará thrives on the drier and hotter plains.

A writer in the *Indian Forester*,* after reading Mr. Cross's Report on the Castilloa region pointed out the Ghât forests as far as the Nagar division of Mysore as the most likely region to constitute a new habitat for the Castilloa trees. He says:—

"In the interesting account of the *Castilloa elastica* in the last number of the *Indian Forester*, the low forests about Coimbator and the base of the Nilgiri Hills are recommended as the locality in India where it is perhaps most likely to succeed. Were the writer acquainted with the line of Ghât forests extending from thence northwards as far, say, as the Nagar division of Mysore, we feel confident, after a careful perusal of his notes, that he would place his finger on this region as the most likely to constitute a new habitat for his species. After the names, and his description of the climate, soil and general surroundings of the forests where his caoutchouc tree grows will exactly suit that of the lower valleys of the Ghât range. Indeed, looking at the map of the world with our knowledge of winds and rain in the tropics, were it otherwise a very fertile brain would be required to strike out a plausible explanation of the fact. As it is, we know, from the general accounts of travellers that there is a very striking resemblance between the two regions. Where the difference lies, and that a great one, is in the two floras. In the ordinary course of things there can be no doubt about one's ability to grow *Castilloa elastica* in the lower Ghât valleys, but the point which nothing but experiment on the spot can determine is, whether in this tract of teeming fertility and bewildering wealth of species, it can so far intrude on the closely fitting vegetative economy as to conquer an independent position in the forest flora. Most probably it would require some artificial aid to mountain itself, but if its economic value is anything like that stated, this we can afford to give it. Only to a limited extent though, for the same poisonous climate exists here as in the tree's New World habitat. Up to this limit great facilities for working exist. The region we are speaking of is permanently inhabited by aboriginal tribes, who sometimes settle down into villages in healthy localities, at other times retire to the most lonely and malarious portions of the belt where they seem to be dying out, and who sometimes can be depended on for regular work, at other times not. With or without their aid labour for a portion of the year could be easily got from the settled and healthy country above. Very often villages with surplus labour exist on spurs of the Ghâts almost overhanging the low country, a cool and non-malarious climate two or three thousand feet above the sea. Here the forest officer has his hut, and rides up after the day's work is done. Back here too he brings his fever-stricken coolies for a change of air, better than any medicine. The whole forest region below is now pierced by easy Ghât roads at intervals of about 50 miles—the ports of Mysore, as the talented engineer who made most of those in that province has aptly described them. All the most accessible passes are lined by a dusty streak along which the produce of the up-country passes to the sea. In a word, in

* Vol. iii. p. 57. (July 1876.)

the lower Ghât forests we can offer *Castilloa elastica* a habitat quite as unhealthy as its own in America, and an amount of care and culture it could not get there.

"Away from the trunk roads and the valleys abutting to them, minor forest produce should be attended to.

"It is a question whether the existent minor forest produce could not profitably be more extensively worked; it is certain that the successful introduction of *Castilloa elastica* would unmistakably turn the scale in the right direction. We would not, however, have it thought that we staked bringing down the trembling beam on this one species. Many others will occur to everybody, but *Castilloa elastica* seems to open up a fairer prospect than them all. There is our old, now familiar friend, *Ficus elastica*, which seems likely to grow well enough here, provided we kept down hardier native species; probably it would require a good deal of aid in this way. There is also *Hevea elastica*, and in fact the whole series of caoutchouc-yielding trees, not forgetting the wonderful Burmese climber, *Chavannesia esculenta*. Since, however, *Castilloa elastica* admittedly produces one of the finest India-rubbers one would naturally wish to begin by trying that. Considering the inaccessibility and unhealthiness of the lower Ghât forests, we seem to have a case here of what our forefathers would have described as a providential adaptation of ways to means, in the fact that the locality is nevertheless so well fitted to produce an article, so necessary in the arts, and of such a growing application, as caoutchouc."

While the *Castilloa* will find a new home in western Ghâts, the *Hevea* is introduced into one of the moist zones of India, the *Ficus elastica* is cultivated in its native forests of Assam, and the *Chavanesia* in Burma, the *Ceara* rubber, with quite different habitat and requirements may be extensively grown on the hot dry plains of Eastern India. The measure if intelligently and continuously followed up will thus ensure in the future, and as the demand increases, a regular and large supply of the best kinds of caoutchouc from British India.

NOTES ON SOME TREES YIELDING INDIA-RUBBER.

(*By* Dr. Trimen *of the Royal Botanic Gardens, Peradeniya, 29th March* 1880.)

India-Rubber or Caoutchouc is afforded by a considerable number of trees and shrubs, chiefly, if not entirely members of the families *Euphorbiaceæ*, *Artocarpaceæ* and *Apocynaceæ*. It is to be distinguished from gutta percha, which is a product of trees belonging to the family *Sapotaceæ*.

In its natural condition in the plant caoutchouc is a milk-like fluid, and the channels in which it occurs occupy a definite position in the structures composing the stem, it is of the highest practical importance to bear in mind that the "milk-vessels" occur wholly in the bark, externally to the cambium-layer or vitally active part of the stem where growth goes on. There are none in the wood, nor in the outer corky, papery or green layers, but only in the inner part of the bark, and either adjacent to or in its bast or liber-tissue.

The kinds of rubber-trees at present exciting interest in Ceylon are :—

1. *Ceara Rubber-tree*—Manihot Glaziovii; *Mull. Arg.*
2. *Para Rubber-tree*—Hevea Brasiliensis, *Mull. Arg.*
3. *Central American Rubber-tree*—Castilloa elastica, *Cerv.*

These three are all natives of tropical America, and are in cultivation at both Peradeniya and Henaratgoda gardens. The two former are North Brazilian Euphorbiaceous trees; the last is Artocarpaceous and extends over a wide area from Mexico as far south as Guayaquil on the west coast of South America.

None of these species has been yet subjected to systematic cultivation out of a botanic garden, but the efforts of the Indian and Home Governments, extended over many years, have at length brought us to the eve of that long-desired result. It will therefore be well to make public what is known of the nature of these plants, of their surroundings in their native localities, and of the methods by which the product is obtained and prepared. Our information is unfortunately but scantly, being mainly derived from the somewhat meagre accounts of the few travellers who have had the opportunity of seeing the trees wild, and especially of the veteran collector, Mr. R. Cross, employed by the Indian Government, by whose energy and perseverance they were brought to England.

From these extracts, and from the results of the cultivation of the trees at Peradeniya and Henaratgoda gardens, it is hoped that some answer to the numerous questions recently addressed to me by planters and others may be given, and some guidance afforded towards a successful cultivation in Ceylon.

I.—Ceara Rubber.—*Manihot Glaziovii.*

1.—*Locality, Soil and Climate.*—Ceará is a coast town of Brazil in lat. 4° S., and the flat country which runs back to the hills is described by Mr. Cross as manifestly possessing "a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca and other crops require to be irrigated. The rainy season is said to begin in November and end in May or June; torrents of rain are then reported to fall for several days in succession, after which the weather moderates for a brief space. According to some statements there are occasional years in which hardly any rain falls. This assertion concurs with the aspect presented by the country in general. The daily temprature on board the ship ranged from 82° to 85° F., but inland it is often probably 90°. The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea." At Pacatuba, about forty miles from Ceará, the actual place where the specimens were obtained, "the general forest was tolerably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. The soil was in places a sort of soft sandstone or gravel which was bound up in the most extraordinary manner. Neither grass nor weeds grow among this underwood, and there was an entire absence of ferns, mosses, and other plants." In another place somewhat further from the coast, the traveller shortly after entering the bush-like forest "came on a large tract of land covered by immense masses of grey granite, some of which might be fifty tons or more in weight. These had been broken where they lay, and were the result of a volcanic explosion. Rounded masses of the same rock also cropped out in many places..............Many good-sized rubber trees were growing in the spaces between these granite masses..............The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs, were not perceived."

2.—*Propagation and Planting.*—Mr. Cross's directions are as follows:—"Seeds are early produced, if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest the formation of plantations by cuttings, which will take root as easily as a willow. These should be taken from the points of strong shoots and may be one foot in length. In planting, each cutting may be put down in the soil to a depth of six inches. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all of which will grow if covered with half-an-inch or so of soil. On loose sandy soils or exhausted coffee land, plantations may be formed at little expense. Hard dry gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper and a stout cutting put into each and filled with pebbles. On bare or thinly-covered

portions of rock the cuttings might be laid down flat, and a little heap of stones or any kind of *debris* about the size of a molehill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. I do not advocate planting in an entirely barren desert, but wherever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper."

Experience of the plant in the botanic garden here has proved the general accuracy of the above remarks. There can be no doubt of the hardiness of the species, its readiness of culture, and adaptability to circumstances. It grows equally readily from seed or from cuttings, and, though native of a tropical sea-level, thrives well here in Ceylon up to at least a level of 3,000 feet, and on the most barren soils. It has succeeded equally in Calcutta and Madras, but the wet season appears to have killed it at Singapore. It would seem especially adapted for the dry and barren districts of our Eastern and Northern Provinces, or in the higher districts, but it would not be wise to risk it in localities where the temperature is liable to fall below 60° F.

Germination of Seed.—The seed coat is of remarkable thickness and very hard, and the natural process of germination occupies a long period—it is said more than a year. All that is necessary to hasten this, if desired, is to assist the seed coat in splitting. This is best effected by holding the seed firmly, and rasping off with a file both edges at the radicular end.* It is best not to file off the actual end, as it may thus easily happen that the radicle of the embryo may be injured. After this treatment, properly performed, the young plant appears above ground in two or three weeks. The seedlings require no particular attention. They grow rapidly and may be finally planted out at distances of twenty feet. A peculiarity which they share with their close relative the mandioc is the possession of large tubers on the spreading roots. The trees at Peradeniya, from which seed has been distributed to Burma, India, Jamaica, &c., flowered at the age of eighteen months, and at the present time (at 2½ years) the larger ones form branching trees about 25 feet or 30 feet high, with a stem 1 foot 9 inches in circumference at a yard from the base, and a smooth, silvery birch-like bark readily peeling off, being about half the size of those which Mr. Cross describes, and which may be assumed to have been fully grown.

3.—*System of Collecting the Rubber.*—I quote again from Mr. Cross's report:—"This is an operation of a very simple description. On commencing to work the collector takes with him a stout knife and a handful of twigs to serve as a broom. Arriving at a tree, any loose stones or dust are swept from the ground around the base, and some large leaves are laid down to receive the droppings of milk which trickle down. Some do not go to the trouble of sweeping the ground or laying down leaves, for which reason the milk adheres to sand, dust, decayed leaves and other impurities. The outer surface of the bark of the trunk is pared or sliced off to a height of four or five feet. The milk then exudes and runs down in many tortuous courses, some of it ultimately falling on the ground. After several days the juice becomes dry and solid, and is then pulled off in strings and rolled up in balls or put into bags in loose masses. Only a thin paring should be taken off, just deep enough to reach the milk vessels; but this is not always attended to. Nearly every tree has been cut through the bark, and a slice taken off the wood. Decay then proceeds rapidly, and many of the trunks are hollow. In this condition the trees must yield far less milk, and many no doubt are broken over by the wind or wither away. Collecting is carried on during the dry season only, when rain seldom falls.

Mr. Cross says nothing as to the age of the trees so operated upon: probably the collectors treat all indiscriminately. In the sequel of his report,

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* This end is to be recognized externally by possessing at its side a flat two lobed appendage technically known as the caruncle.

however, he incidentally remarks that Ceará rubber may be tapped on attaining "a diameter of four to five inches," which is the case here in Ceylon after about two years' growth. But unless there were a very large number of trees in an extensive plantation, this would certainly be labour thrown away. The trees, however, comes so early to maturity, as shown by the production of seed, that it is improbable that it attains any very great size. The process above described must be, if thoroughly done, almost exhaustive of the milk, but in the case of a small stem it would be a work of some care and time to so conduct it as to avoid cutting into the wood, and probably some of the methods afterwards described will be preferred. But these are practical difficulties which it may be safely assumed the ingenuity of our planters will quickly master.

II.—Para Rubber.—*Hevea brasiliensis.*

1. *Locality, Soil, and Climate.*—The town of Pará occupies a position near the mouth of one of the vast embouchures of the Amazons in about south latitude 1°, but the district of the same name extends over a vast forest region to the south and west, throughout which and the enormous forests of central and northern Brazil this and allied spiecies are abundantly found. The climate has been often described and is remarkable for its uniformity of temperature, usually not exceeding 87° F. at midday or below 74° at night. The greatest heat recorded is 95° and the mean for the year is 81°.

The rainfall occurs principally during the months from January to June, the maximum being in April when it reaches 15 inches. For the remaining six months of the year very little falls, but there are fine days in the wet seasons and occasional showers in the dry. The whole country is covered with dense moist forests, and the soil near the numerous and gigantic rivers is deep, heavy, and very fertile. During the wet season much of the lowlying country near the Amazon's mouth is flooded. In the *gapos* near Pará, visited by Mr. Cross, he found a flat district only three or four feet above the highest tides and completely intersected with water-courses at low tide, filled with a soft rich mud. The forest here, in which caoutchouc-collecting was vigorously carried on, was 80 or 100 feet high, and very damp and unhealthy, the soil full of moisture and very rich and fertile. The young plants however were not often observed to grow actually within the reach of the tides, but it is evident that they must frequently be subject to be partially covered with water.

2. *Propagation and Planting.*—This valuable species as yet has been propagated from cuttings only. No fresh seeds were brought to this country, but to judge from dry ones in the herbarium of the British Museum, London, they are considerably larger than those of the Ceará rubber. Our largest trees at Henaratgoda, three years old, are thirty feet in height with a slender stem scarcely branched, and about twelve inches in circumference near the base; but neither there nor in Peradeniya have they shown any symptoms of flowering.

Cuttings may be taken from the green lateral twigs as soon as they begin to harden; they strike readily in rich firm land. Mr. Cross observes that "for planting on inundated lands the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower ends of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and wading into the water would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than three or four inches is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves...........

It should be planted in places were nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits." It would not be desirable to form a plantation in any locality where the temperature at any time falls to 60° F.

The tree when fully grown does not exceed a height of about sixty feet, and the largest trunk measured by Mr. Cross was six feet ten inches in circumference at a yard from the ground. From the upright habit of the tree it will not be necessary to plant at any great distance apart.

Over 500 plants have been sent from Ceylon to Burmah and some to the Madras Presidency. An attempt to grow the tree in Assam failed.

3. *Collection of the Rubber.*—Several accounts have been given of this, the fullest and most recent being that of Mr. Cross, who saw in practice the methods employed in the neighbourhood of Pará. His description is as follows:—

"The collectors begin to work immediately at daybreak, or as soon as they can see to move about among the trees. They say the milk flows more freely and in greater quantity at early morn. I do not attach much importance to this statement, but I have recorded it. Another and more probable reason is, that as rain often falls about two or three o'clock in the afternoon the tapping must be done early, as in the event of a shower the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a certain number of small cups of burnt clay. At the lesser trees only three or four are put, but at the larger ones from eight to twelve are deposited. The footpaths leading from tree to tree are likwise cleared of sapling growths, and the bridges over the *gapos* [natural ditches] formed at each place by the trunk of a tree are, where necessary, replaced. On proceeding to his work the collector takes with him a small axe for tapping, and a wicker basket containing a good-sized ball of well-wrought clay. He usually has likewise a bag for the waste droppings of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and from the 'negrohead' of the English market. The cups, as already stated, are of burnt clay, and are sometimes round but more frequently flat or slightly concave on one side, so as to stick easily when with a small portion of clay they are pressed against the trunk of the tree. The contents of fifteen cups make one English imperial pint. Arriving at a tree, the collector take the axe in his right hand, and, striking in an upward direction as high as he can reach makes a deep upward sloping cut across the trunk, which always goes through the bark and penetrates an inch or more into the wood. The cut is an inch in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down he takes a cup, and pasting on a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time the milk, which is of dazzling whiteness, is beginning to exude, so that if requisite he so smooths the clay that it may thickle direct into the cup. At a distance of four or five inches, but at the same height another cup is luted on, and so the process is continued until a row of cups encircle the tree at a height of about six feet from the ground. Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by nine or ten o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours or perhaps longer. I may state that there is a great difference among collectors in the performance of these duties. Some take care to get good clay previously and incorporate it well, so that a very small portion is needed to lute the cups to the trunks; they also work with neatness and intelligence, and invariably collect a good quantity of milk. Others, again, do not take the trouble to prepare clay beforehand, but merely scrape up a handful when they require it at the side of a *gapo*, which is often of little consistence, so that a large quantity is required to fasten the cups. This class of collectors have often many

fragments of clay or other impurities in their milk, the result of not following a proper method of working. The quantity of milk that flows from each cut varies, but if the tree is large and has not been much tapped, the majority of the cups will be more than half full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapo* or dry land, many of the cups will be found to contain only about a table-spoonful of milk, and sometimes hardly that. On the following morning the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made from six to eight inches lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from a tree is great, two rows of cups are put on at once, the one as high, as can be reached, and the other at the surface of the ground, and in the course of working, the upper row descending daily six or eight inches, while the lower ones ascends the same distance, both rows in a few days come together. When the produce of milk diminishes in long wrought trees, two or three cups are put on various parts of the trunk. where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of overtapping, as some have stated. Indeed I do not believe it is possible to overtap a tree if in the operation the wood is not left bare or injured. But at every stroke the collector's axe enters the wood and the energies of the tree are required in forming new layers to cover those numerous wounds. The best milk-yielding tree I examined had the marks of twelve rows of cups which had already been put on this season. The rows were only six inches apart, and in each row there were six cups, so that the total number of wood cuts within the space of three months amounted to seventy-two. It grew close to a *gapo* only eight inches above high-tide mark, and being a vigorous tree the cups were usually well filled, but with two years or so of such treatment the tree would probably be permanently injured. It has been supposed that the quantity of the milk is better in the dry season than during the rains. Such is the case with some vegetable products, but as regards India-rubber there ought not, I think, to be any appreciable difference. In the rainy season the milk probably contains a greater portion of water, but, on the other hand, I am of opinion that then a larger quantity of milk flows from the tree. No doubt the dry season is the most suitable for caoutchouc collecting, although, wherever a plantation is formed with preparing house convenient tapping may certainly be always carried on when the weather is fine.........There are two other methods adopted in tapping, which are chiefly confined to the upper Amazon and tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree is cleaned off to a height of about three feet. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half of the entire circumference. Cuts are thickly made in the bark above this, from which the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by winding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk may escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of 'negrohead,' the result of the distance the milk has to run, and to the large quantity of clay employed in the process.

"*Collection of the Milk.*—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or fore-finger over the bottom to clean out some which other-

wise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off and classed as *sernamby*. The cups on being emptied are laid in a little heap at the base of each tree, to be ready for the following morning. The trees occur at various distances from 10 to 100 yards apart, and as I travelled over the intricate network of muddy footpaths, I continually felt perplexed and surprised that the natives have not yet seen the advantages that would be derived by forming plantations, whereby more than twice the quantity of caoutchouc might be collected in one-fourth the time, and at far less cost and labour."

The trees are tapped if they have a circumference of eighteen or twenty-four inches, and the rough process above described is carried on for many years, until the constant and extensive injury to the young wood causes their death, for some years previous to which event they almost cease to yield milk and are practically abandoned.

It will be advisable, in order to avoid this injury, to employ an instrument for cutting so shaped and guarded that it shall not be able to penetrate beneath the inner bark. With this precaution it will probably be found unnecessary to rest the trees as has been recommended by some; but actual experience alone can decide on the method of tapping which will secure the greatest yield with the least damage to the tree's general vitality.

III.—Central American Rubber-tree.—*Castilloa elastica.*

1. *Locality, Soil and Climate.*—The very extensive geographical range of this tree shows it capable of existing under considerably varied climatal conditions. The forests in which it grows are usually at or near sea-level, but it has been observed at an elevation of 1,500 feet on the Pacific coast. The soil varies, but the plant avoids marshy or boggy land, appearing to prefer warm deep loam or sandy clay, and especially affecting the margins of small running streams where it grows in little groups. A dry or a rainy climate seems equally suitable, but a high and equable temperature, which does not sink below 60° F. at any time, is essential.

2. *Propagation and Growth.*—This is a very much larger tree than those above described, being, when fully grown, of the imposing height of 160 to 180 feet, with a stem of 12 to 15 feet in circumference. It grows very rapidly. At Henaratgoda at two years of age it was 23 feet in height. The bark is thick, and the wood soft and readily decaying. We received but a few plants of this species in Ceylon, and have had little experience in its management. No flowers have been yet produced, and Dr. Thwaites did not find cuttings of the ordinary kind to succeed well. We are now however endeavouring to propagate at Peradeniya by various other methods.

Mr. Cross has the following remarks:—"Trees in good situations will produce seeds early, but these will require to be planted without delay as drying destroys their vitality." The tree is stated to flower in January, and the fruit to be ripe in April. "Stout branches, cut into pieces each possessing a bud and covered lightly with soil, will generally be found to grow. Strong cuttings a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceará rubber. In the planting out of young plants, the petiole or leaf-stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous, and the trunk symmetrical. But if at the period of planting there is much bare stem above ground, the growth is usually slow, the plant remains 'leggy' for some time afterwards, and never makes a good tree." The plant has a curious habit of dropping its young branches, which disarticulate by a regular joint, like deciduous leaves, and leave a clean scar

on the surface of the stem. From what has been said above as to its native cities, it would seem that our south-western coast would present many favourable localities for this valuable tree.

3. *Collection of the Rubber.*—Milk is abundant and flows readily, but it is of a somewhat more watery consistence than that of the Pará rubber. In consequence of the large size of the trees it is the practice of the collectors in Panama and other parts to cut them down. A groove or ring is first cut round the base of the trunk and the milk received into large leaves. "The tree is then felled, and rings or channels are cut out around the prostrate trunk at about twelve or fourteen inches apart," and the rubber allowed to run into leaves or vessels. In Nicaragua the trees are tapped with sharp axes in various ways, and the trees so much injured that the process is performed at intervals of three years. The milk is received into iron pails. It does not appear that this species is tapped until it has a diameter of sixteen or eighteen inches, which Mr. Cross thinks might be attained in six years.

In conclusion, a few words may be said about the preparation required to fit caoutchouc for the market. It is clear that mere exposure to the air is sufficient in some cases to effect the coagulation of the milk into a solid mass. This is all the peparation apparently that the Ceará rubber receives, which comes into the market in balls consisting of the rolled, up strings pulled off the tree. But it seems that a decomposition is liable to occur in the milk if exposed in any quantity, and it is usually desirable to reduce it to a solid mass as quickly as possible. For this purpose the cautious application of dry heat is the best; the best Pará rubber is prepared by being poured over a flat paddle-shaped mould, which is held in the thick hot smoke from burning wood and palm-nuts still it solidifies, then slit down one side, the mould taken out and the "biscuit" hung up to dry. In several parts of Central America coalescence is effected by the addition to the milk of the juice of certain plants (especially of *Calonyction speciosum*, which is a common convolvulus here in Ceylon). This causes the separation of the caoutchouc, which floats in the liquid like a mass of soft cheese, and has to be pressed and rolled to get rid of the fluid still remaining in its substance.

Probably carefully conducted evaporation in shallow pans by artificially regulated heat would be found an effective method.

The purity of the prepared rubber being a matter of first importance, all pieces of bark and earth should be removed by passing the milk through sieves. Small pieces or thin sheets of caoutchouc are preferred to large masses in the market from the facility of estimating the purity of the article.

Absolute dryness of the rubber is also a point requiring the greatest attention, and may require hydraulic pressure for its thorough attainment.

As much as 129,163 cwt. of caoutchouc were imported into England in 1874, of which 70,866 cwt. was American and obtained from the plants here under consideration. The value of this latter was £1,007,413. The demand for the best sorts is constantly increasing. On the relative market values of the various kinds of India-rubber reference may be made to the excellent "Report on the Caoutchouc of Commerce" by Mr. Collins, and printed for the Indian Government in 1872, to which I am indebted for some of the above information, and to a paper by Mr. C. R. Markham in the "Journal of the Society of Arts" for April 7th, 1876.

I may be permitted to add that it is gratifying to reflect on the prominent share which the Royal Botanic Garden at Peradeniya, under the care of my distinguished predecessor, Dr. Thwaites (as detailed in his Reports from 1875-1878), has taken in the acclimatization of these valuable trees of the western hemisphere in Burmah and India; where, as well as in Ceylon, it may be confidently expected that they will become a valuable source of revenue.

COLLECTION OF THE JUICE OF THE INDIA-RUBBER TREE IN PARÁ.

(From the *Journal of the Society of Arts*, July 30th, 1880.)

The operation of collecting the juice of the tree, either shells or clay vessels are attached to receive the exuding milky sap and when sufficient of this has been collected, the operation of drying it is performed as follows:—A kind of wooden bat thinly covered over with clay, is dipped into a pail filled with juice, and the bat, thus coated, is held over a fire, fed with certain wild nuts, which, in burning, give off abundance of aromatic smoke. A kind of short chimeny is fixed over the fire to lead the smoke compactly upwards. As soon as the first layer of juice has become indurated, the bat is again dipped, and the drying operation is repeated; layer after layer being thus dried on the bat, until a thickness of nearly an inch is attained. A knife cut is now made in the bottle or biscuit of caoutchouc thus obtained, so that it can be removed from the wooden bat, and exposed to the air to become still further indurated. Pará caoutchouc, prepared in this manner, has a fragrant aromatic odour, which you can study for yourselves in the samples now before you.

The residues of juice left in the various vessels employed, the scrapings of the incisions, together with other materials, which the ingenious native thinks he can shuffle off on the unsuspecting merchant as caoutchouc, are made into balls, and sold as "negro head." The negro head-rubber is frequently made into crude representaions of animals, and there are several such works of native art on the table—as, for example, this specimen, which will pass about equally well for a horse, a pig or a crocodile.

The milky juice of the Pará rubber trees, of which you see a specimen before you, has approximately the following composition:—

Caoutchouc	32
Albumenous, extractive, and saline matters ...	12
Water	56
	100

As a rubber producing tree, the *Ficus elastica* stands next in importance of the Heveas. The *Ficus elastica* grows abundantly in India and the East Indian Islands, one district in Assam, thirty miles long by eight miles wide, being said to contain 43,000 trees, many of them attaining a height of a hundred feet. This tree also grows freely in Madagascar, and it is well known to us as a green-house plant. The slide now projected on the screen represents the *Ficus elastica* in its native regions; and I will next show you one illustrating a *Ficus elastica* now growing out of the doors in the Parc Monceau at Paris.

The juice of the *Ficus elastica* contains notably less caoutchouc than that of the American trees, the proportion very often falling as low as 10 per cent of the juice.

A wine-like plant the *Urceola elastica*, which grows abundantly in Madagascar, Borneo, Singapore, Sumatra, Penang, and other places, yields a considerable amount of caoutchouc of very good quality, and you will find specimens of the substance from these districts on the table.

Africa yields a considerable quantity of caoutchouc, but generally soft and of inferior quality. It is believed to be yielded by various species of landolphia, ficus and toxicophlea. Here are some specimens of African rubber. This specimen, representing the quality known as African ball being tolerably firm in consistency, while the African flake, which you see here, and the African tongue represent the lowest and most viscous qualities of commercial rubber. In order that you may compare the two extremes of quality, I will hand round specimen of fine Pará together with a piece of African tongue.

NOTES ON CAOUTCHOUC.

BY G. W. STRETTELL.

NATURAL ORDER APOCYNACEÆ—(*Lind.*) DOGBANE TRIBE.

Chavannesia esculenta. Vernacular (in Burmah) "*Kyet-poung-hpo.*"

DESCRIPTION.—Trees or shrubs, usually milky, allied to the *Asclepiadaceæ*, and differing from them in the contorted œstivation of the corolla, distinct filaments, granular pollen, and a peculiar hour-glass-like stigma.

DISTRIBUTION.—Natives of the tropics of Asia, America, and Africa. Known species, 570. *Ill. Gen.*,—Allamanda, Carissa, Cerbera, Tanghinia, Urceola, Vinca, Plumiera, Balfouria, Strophanthus, Nerium, Apocynum, Echites, Cleghornia, Mandevilla.

PROPERTIES.—Many of the plants are poisonous, some are drastic purgatives. The bark is sometimes tonic and febrifugal. The milk of several species supplies caoutchouc.—*V. K., p.* 599.

As far back as 1860 we find in Mason's *Burma* the following mention of a gum-elastic-yielding creeper, whose caoutchouc is scarcely inferior to that of the *Ficus elastica*, and which as recently as last August was valued by a European firm in Rangoon at R200 per 100 viss.

As indigenous creeper yields caoutchouc not at all inferior to that which is obtained from the elastic fig-tree. The Agricultural and Horticultural Society, in reporting on a specimen sent them by Major Macfarquhar, of Tavoy, observed, with care in preparing, it would be equal to the best South American. I have never seen the plant in flower, but, to judge from the fruit, it belongs to the dogbane tribe, and *echites* group, for its seeds are comose above. It was stated in the *Friend of India* a few months ago that Captain Power had forwarded specimens of India-rubber from Rangoon, the exudation of a plant supposed to be the *Urceola elastica*. In the absence of any description of the plant, we may suppose it identical with the one in the Tenasserim Provinces. Mr. Parish writes me,—"I think you are right, and I believe the plant to be *Echites macrophylla* (Wight). It is a splendid creeper, and yields apparently excellent caoutchouc. I find it on Beluguen."

2. My attention was first drawn to this creeper when crossing the hills east of Talo last January, lat. 25° 33′, long. 97° 40′, elevation 2,300 feet. Halting at the Kachyen hamlet of Nansing to give my people a half hour's rest preparatory to making our next ascent and encamping for the night, my attention was drawn to a Kachyen girl busily engaged dyeing some homespun thread, with what appeared indigo, before arranging it for the loom. This turned out to be a mere decoction obtained from equal parts of the leaves of the *Ruellia indigofera* and *Chavannesia esculenta*.* So good was the imitation to what I mistook it for, that it would require some little experience in the two dyes to distinguish the difference, and I would strongly urge its introduction into the jail as a substitute for indigo.

3. The next morning, shortly after leaving Nansing, we came on this creeper growing in prolific abundance all over the forest, a large proportion of the trees being entwined by it. I collected specimens of the leaves and milk, which latter I found had partially consolidated within a few hours of

* Mr. S. Kurz, in reply to a reference I made, kindly wrote as follows:—"The drawing and Plant of *Chavennesia esculenta* is chiefly found in Tenasserim and Martaban, and was not known to occur also in Pegu. I myself did not meet with the plant, or more probably overlooked it. A very similar plant, of which I enclose a leaf, is common on the Pegu Yomah, and is *Anodendron paniculatum*, (*a*). It is easily distinguished by the nerves and transverse venation beneath being very obsolete, while in your plant they are very prominent. It produces also caoutchouc, but of what quality I do not know." * * *

[*a*] *Note.*—I have also specimens of this creeper, but the rubber is far inferior, and less elastic than *C. esculenta*.—G. W. S.

apping. Now, for the first time I learnt from my interpreter that this creeper was not only common to our own forests, but even cultivated by the people on account of its fruit, which has an agreeable acid taste, and, being in season when tamarinds are not procurable, is readily purchased by the Burmans for culinary purposes, and sells in Rangoon at an anna per bunch of ten pods.

4. On my return to Rangoon, I found Mr. Nepean had been writing on the subject of different milk-producing shrubs, one of which he reported to be *Landolphia owariensis;* but this was a mistake, and as he seemed quite to have lost the art of producing caoutchouc similar to the sample forwarded with his letter, I did not interest myself more in his writings, but worked out results for myself. I prepared specimens of Indiarubber obtained from the *Chavannesia esculenta* growing within a few miles of Magayee, and solicited the favor or Mr. Hervey, late Assistant Superintendent of Telegraphs kindly submitting it to an electric test; his report I here quote verbatim:—

"I have carefully tested this piece (A) of rubber with the only apparatus we have for the purpose. It is not, I am sorry to say, as sensitive as it might be, but with a battery of 16 cells not the slightest current passed through it;—for insulation it may be said to be perfect, but to what degree I cannot say, as we have nothing to measure it by. The rubber was soaking in water all Saturday afternoon and yesterday, and has stood that test apparently without any change whatever."

5. I next addressed Messrs. Galbraith, Dalziel & Co. on the subject of its marketable value, and their reply I also quote *ipsissimis verbis*:—

"In reply to your favor of yesterday's date, No. 534, accompanied by specimens ot caoutchouc, the quantity sent is scarcely sufficient to give a proper opinion of the quality: judging, however, from what you have sent, we consider the quality to be very fair, and at the present market value of about R200 per 100 viss. We will thank you if you will procure and send us a good parcel,—say about 100 viss,—which we will pay for at the foregoing rate if of equal quality to the specimens herewith referred."

6. I then subjected my manufacture to a few chemical tests, which gave the following results, and will be found to nearly correspond with those obtained from *Siphonia cahnchu.* It is insoluble in water, acids, or alchol, but dissolves in æther, bi-sulphuret of cardon, oil of sassafrass, and tupentine. When formed into solution by æther, its properties remain unchanged on evaporation of the menstruum. Specific gravity of consolidated caoutchouc, 1975.

7. More recently, Mr. Galbraith very kindly also had the specimens submitted to chemical analysis, which showed that "rubber tried by all the usual solvents gave the same results as ordinary rubber; it also produced oil-rubber by distillation."

8. The foregoing data, then, I think is sufficiently encouraging to warrant the cultivation of this creeper being introduced as a branch of forest administration on an extensive and systematic plan; and it is only astonishing that so valuable a product in which our forests abound should have remained thus long unutilized or thought of.*

9. I will now deal with the system under which I would suggest this creeper be cultivated by the Forest Department; but before this can be successfully accomplished, we must have some more definite control over the areas within forest limits than what at present exists.

10. This creeper may be propagated either from seeds or cuttings. The former I would recommend, as natural reproduction is abundant wherever the creeper grows, and we can make certain of results if the plant lives; but not so with cuttings, which do not in every instance equal the parent tree—a phenomenon in vegetable physiology yet to be accounted for. Regarding the mode of planting, we must for the present follow the natural habit of the plant,

* *Chavannesia esculenta* is one of the several creepers for whose extermination in teak tracts an annual budget provision is made.

which is to entwine itself round its more stalwart companions of the forest. reaching from one to another in the most fantastic forms and shapes, until its trunk has gained sufficient strength to make it independent of its original support, which may long since have fallen a victim to its suffocating embrace.

11. There is no necessity to preserve any fixed distance at which to plant this creeper, nor to go to any great expense in starting the system. Let seedlings be established at the base of every tree unsuited for other purposes, within a given area, which for the present need not exceed 400 acres. There are plenty of such sites to be found near the Magayee plantation, but it will be necessary at once to put a stop to the felling of all descriptions of tlrees, and to guard against fires and cattle-trespass.

12. Planting should commence immediately the rains have set in, and vegetable life has taken a fresh start; natural reproduction then being plentiful, seedlings may be collected and planted at a reasonable cost; but, to guard against blanks from any unforseen causes, nurseries of half-an-acre each should also be established in localities where artificial irrigation may be conducted at a reasonable rate. This will admit of the nursery operations being commenced about April, so that by the middle of the monsoon the seedlings will have made sufficient growth to admit of their establishing themselves in their new homes before the cold season comes on.

13. In respect to soil, the difficulty would be to name a class unsuited to this creeper, for I have seen it growing in luxuriant profusion in localities where the soil was antipodal, both as regards the organic and inorganic components. In the quasi-evergreen, mixed *Dipterocarpus* belt which intersects the vegetation of the plains and that of the more hilly tracts adjoining the Magayee plantation, the soil is all that could be desired; but care of course must be taken not to select marshy land, nor land where water is stagnant.

14. No indisputable information being obtainable as regards the rate of growth of this creeper, the following figures must be received with caution, though every effort has been made to secure the most reliable data by a comparison of statements made by the different parties who have propagated the creeper for the benefit of its fruit. The following measurements were obtained from creepers growing near Rangoon and Thamine:—

"No. I.—Growing on *Accacia concenna* of 18 feet high, with trunk 5 feet from the ground, 18 inches circumference. Thickest stem of *C. esculenta*, 9 inches circumference. Space covered by crown branches, 300 square feet, age said to be five years; growing on laterite soil.

"No. II.—Originally started on *Malicocca trijuga*, but now entwines three trees. Thickest portion of stem 11 inches. Soil, sandy loam. Said to be seven years old.

"No. III.—Originally entwined on Mango, now extends over four trees. Thickest portion of stem, 10½ inches. Soil sandy loam. Said to be seven years old."

15. "Now, allowing the foregoing data to be approximately correct, and assuming the trees to be 30 feet apart, the following details will enable us to form a fair idea of the probable financial results. Area to be cultivated 400 acres. Trees at 30 feet by 30 feet, equal per acre 48, or 19,200 creepers in 400 acres. Minimum yield of caoutchouc per annum, estimated at one viss per creeper, equals 19,200 viss, or, at R200 per 100 viss, R38,400 per annum.

16. The cost of starting this project will be trifling in the extreme. All that will be necessary ought not to exceed, on an average of seven years, R4 per acre per annum. After the first year the creepers will have attained a sufficient height to require little or no further attention, beyond, of course, protection from fire, &c. Thus, at the end of seven years the cost on 400 acres would represent R11,200; and even this expenditure migh be reduced if Shans or others were induced to sell their labour for the privilege of cultivation within the area free of taxes; while a still further reduction might be brought about by intermediate sowing, tapping each alternate creeper to death immediately it commenced to interfere with its neighbour.

17. At the expiration of seven years the expenses will embrace tapping, pressing, and preparing the caoutchouc, which I estimate at 12½ per cent. of the profits. According to these figures and the present market value of the Indiarubber of this creeper, the net assets of this scheme may be approximated at R33,600 per annum.

18. The milk of this creeper apparently more readily coagulates than that of the *Ficus elastica*, for I have known it resolved into a coagulum floating in an aqueous solution within a few hours after collecting, and without exposure to the direct rays of the sun, or artificial heat of any sort. This consolidated mass should be collected at once, and all moisture expelled by means of graduated pressure, to be accomplished either by a sort of mangle, or press something on the principle of a cutch-press, the side being perforated, so as to admit of thorough drainage. The aqueous portion however, should not be thrown away, for it still holds in suspension particles of caoutchouc which will solidify and coalesce if subjected to artificial heat and a final system of pressing will produce rubber equally valuable to that in which the coagulum had formed unassisted.

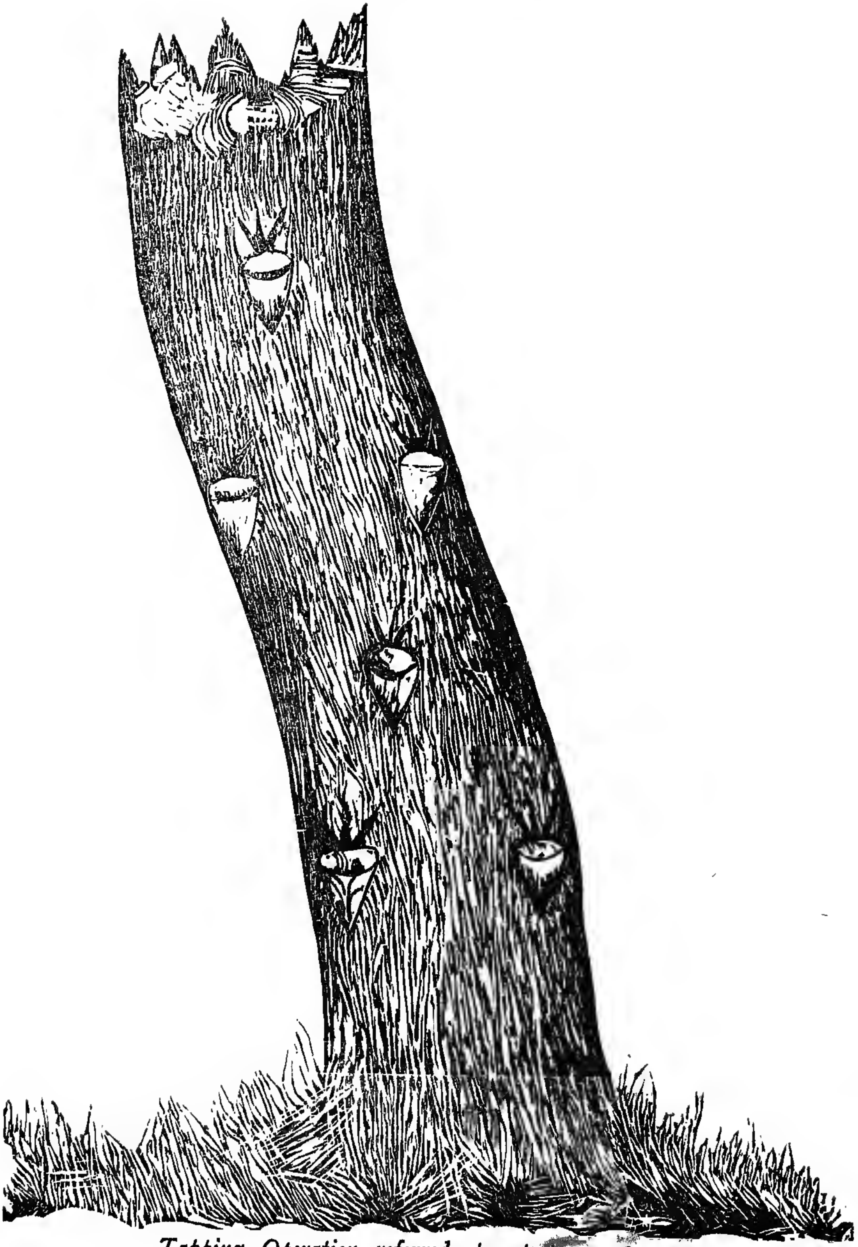
19. The lactiferous vessels are those that yield the inspissated milk *sui generis*, and flows most abundantly from the *mesophlæum*. When tapping, care should be taken not to cut into the sap-wood. To those unacquainted with this subject, the most practical way of understanding what is implied by the *Cinenchyma* vessels and *mesophlæum*, is to cut a deep V into the wood and watch whence the inspissated secretions flow. This is the method I adopted to tutor a couple of my men, both of whom can now make the incisions and tap with unfailing accuracy.

20. The cut I adopt is in the form of an arrow, and the incisions are made on three sides of the stem. The tiers of arrows should be three feet apart, and so regulated that the cuts do not come in a perpendicular line with those below. At the point of the arrow I attach a funnel, formed out of the leaves of the *Butea frondosa*, which readily attaches itself to the tree, from the glutinous nature of the milk. Any other leaves will answer equally well if sufficiently large, and proof against cracking. I have named the *Butea frondosa* as the one I used and found to answer the purpose.

21. Burmans, like most other eastern races, are an improvident lot, and always ready to kill the goose for the golden egg: they will cut down a tree rather than climb it for the fruit, as I have often observed: and so with the tapping of trees,—if they are not looked after, to save trouble, they lop off the branches and collect the milk from the amputated extremities.

22. The season for tapping these trees is about the end of April. Between October and March circulation is slow, and milk scarce: but during the rains the milk is more aqueous, and flows more readily. To give the system a start, and stimulate others to bring the caoutchouc into the market, I have arranged with a Burman to purchase any quantity of the milky emulsion at a fixed rate, to be delivered either at Rangoon or Magayee. The art of manufacturing caoutchouc not being known to the people about here, I have been in a measure obliged to agree to terms that under other circumstances I should have declined—I refer to delivering the milk in a liquid state, and also to its delivery at the former station; but under other conditions, I found the plan was likely to fall through, and, as the system can be re-organized at any moment, we must not be too particular at the start off.

23. Since completing this paper, Mr. Galbraith, senior partner of Messrs. Galbraith, Dalziel, & Co., informs me that his chemical tests prove the rubber of *C. esculenta* to be purer, and better suited to their purposes, than that obtained from the *Ficus elastica*.



Tapping Operation referred to at page 46, para 20.

FROM A REPORT ON THE CAOUTCHOUC OF COMMERCE BY JAMES COLLINS, F. R. S. EDIN.

Improvement in the Collection and Preparation of the Caoutchouc.

Improvements should be effected in the collection and preparation of the Caoutchouc of the *Ficus elastica.* The time of year at which the milk sap ascends to the flowers has an effect on the quantity of Caoutchouc yielded. At the time of flowering of the Heveas scarcely any milk can be obtained from the trunk, whereas the panicles if cut, yield it in large drops. If a tree be tapped too often, without a sufficient period of rest being allowed to intervene between each successive operation, each successive yield is less rich in Caoutchouc and more watery and the tree itself becomes permanently injured. In the wet season there is a larger percentage of water in the milk than in the dry season, and therefore the collection is not so profitable. The time best suited in Assam, Mr. Mann finds to be February, March and April. After tapping, a period of at least three years should elapse before the operation is repeated in order to allow the tree to recover its strength. Judicious tapping does not injure a tree nor check its growth, but the danger lies in over-tapping or bleeding to death. Natives always resort to over-tapping if left to themselves. This impoverishes the tree, and predisposes it to succumb to atmospheric changes, and to the attacks of insects, for healthy trees are not so liable to these latter destructive agents, and very seldom does a tree so injured long survive these united influences.

Mode of Tapping.—In temperate climates, the only tree which is tapped for its juice is the sugar maple (*Acer saccharinum,* L.). This is tapped with an auger ¾ inch in diameter. The trees are perforated with two holes, four or five inches apart, in an oblique ascending direction, 18 or 20 inches from the ground, care being taken that the perforation does not enter too deep. The sap is allowed to run down small channels consisting of split elder stems, &c. When these precautions are taken the tree is uninjured, the wood alone being somewhat softer and less durable, as is the case in the wood of all "tapped" trees.

From the Manna Ash of Calabria and Sicily (*Fraxinus oruns,* L.) the sweet concrete exudation known as Manna is obtained by incisions in the bark of the tree. The tree is not tapped till it has ceased to produce new leaves. Cross or transverse cuts about 2 inches long are made with a hooked or curved knife. This is only done on one side in the season. The following year the incisions are made further round the tree so that in three or four years the first line of cuts, is returned to.

In Nicaragua the Ulé tree (*Castilloa elastica, &c.*) is tapped in the form of a spiral, surrounding the tree at an inclination of about 45°. A single tree often requires 2,000 cuts to complete the surrounding. If the tree be large, two such spirals are made, either cutting each other or running parallel to each other. This is however a very injurious manner.

In Pará, Guiana &c. in tapping the Seringa (*Heveae* sps.) a long perpendicular incision is made from near the base and extending high up the trunk. On each side of this line and meeting it are numerous small oblique cuts. Sometimes a basal cut is made extending some distance round the trunk on each side of the vertical cut. This mode of tapping, especially if made without the basal cut and with slight modifications to suit particular cases, has much to recommend it as it is equally applicable to large and small trees, and in the case of the *Ficus elastica,* which is a congregation of stems, and where all sides are not equally accessible, it can be adopted with ease, whereas the spiral incision can only be used where the whole of the circumference of the trunk is accessible. In the tapping of the stems of *Ficus,* where deeply furrowed, the vertical line alone could be used or diagonal cuts only on the side best suited, and in tapping roots one long cut could be made so inclined as to form a natural channel with smaller ones about it.

Implements used.—In south America and other countries machetes (small

axes) or long knives are used. All these are very bad, as in their slovenly use the tree is gashed in a frightful manner. The huleros in Nicaragua, for instance, before withdrawing the axe after a cut is made, press heavily on the handle in order to open the wound as much as possible, thus extending the injury to a considerable distance.

In tapping, the greatest care should be taken not to injure the *Cambium layer.* This *Cambium layer* is situated on the outside of each annual zone, and is a layer of vitally active cells, in which the new layers of bark and wood are elaborated and given off. If injured, the wood and bark suffer and no new bark consequently cicatrises over the wound. Mr. McIvor's very successful and interesting physiological operation in removing bark from living *Cinchonæ* owes its success to the care taken in order to ensure this *Cambium layer* from injury.

The only effect to provide in such an implement is that it should just remove or cut through sufficient bark to rupture the lactiferous vessels, situated principally in the middle or *Mesophlœum* layer of the bark, and thus allow the milk to escape. The very formation of such a tool should prevent the possibility of "hacking or chopping through the bark. The Manna knives are good for their purpose, and Mr. Mann has sent me a knife which had before suggested itself to me and which is used in the forests of Hanover for marking standing timber, and in this country also for marking timber, and which I have found, when I had occasion to use it for some little time, exceedingly well adapted to the purpose. A similar knife is also used by farriers. The blade which when open forms an obtuse angle with the handle, has its end bent round in a U shape, the lower of it being the only cutting edge. If a few such blades of a larger size, fixed or fixable to long handles for reaching up the trunks of trees, were tried, I believe they would prove a good kind of tool to use. Certain modifications might be made, as possibly to make the point more of a V shape, and a guard running through it such as oyster or preserved meat tin knives are provided with might be added.

After fully considering the various requisite points in order to produce the best form of cutting instrument, I have constructed a small model which I send herewith, and of which a drawing is given. In using it, it is drawn towards the operator, against the bark. The first part of the blade is sharp so as to cut through the bark. This blade gradually widens at its base till at its termination it is wedge-shaped. Above the blade a shoulder projects. The wedge-shaped cutting edge opens the bark just sufficient to allow of the escape of the milk. The shoulder prevents the knife penetrating too deeply, thus preserving the wood from injury. The relative distance between the knife edge and the shoulders can be made according to the thickness of the bark in different species, as all that is necessary is to rupture the milk vessels *(lactiferous tissue* or *Cinenchyma)*. The advantages of this instrument I take to be that of removing no portion of bark, and thus not hindering cicatrization; doing away with the possibility of "hacking;" and also I believe if tried would prove itself a simple and effectual instrument. The handle can be made long or short, or both, as experience may dictate. It may also be made in clasp knife form, the blade when opened forming a more or less obtuse angle with the back of the handle.

Collecting Vessels.—The general collecting vessels are leaves folded up in funnel fashion, clay plastered to the trunk of the tree, or calabashes. Clay contaminates the milk in a very objectionable manner. Iron vessels large enough to hold the product of a single tree might be provided. One side of them might be slightly concave in order to accommodate its side to the tree. Large vessels of the same material would be necessary for the different gatherings.

Preparation of the Caoutchouc.—In reviewing the different methods by which the particles of Caoutchouc are caused to coalesce, from the whey like liquid

in which it is suspended in its recent state, we find they are various. We may however classify them thus:—

Group i.—Coalescence brought about by heat—Examples:

(1.)	Artificial heat (dry)	Pará, Madagascar.
(2.)	,, (hot water)	Assam.
(3.)	Natural heat	Assam, Ceará.

Group ii.—Coalescence brought about by the addition of various substances:

(4.)	Alum	Pará.
(5.)	Liq. Ammoniæ fort?	Pará, African (best kinds.)
(6.)	An acid? (acetic acid?)	Pará.
(7.)	Certain plants	Nicaragua.
(8.)	Fresh water	Nicaragua.
(9.)	Salt water	Borneo, Madagascar.
(10.)	Sulphur	Pará.

Of these various methods that by cautious application of dry heat is generally accounted the best, and the Pará Caoutchouc of the best description is prepared in this manner. The action of the Urucuri and other nuts (*Attalea excelsa*, Mart. &c.) I cannot altogether understand; I am inclined to look upon it as only a ready means wich has suggested itself of drying the Caoutchouc without injuring or affecting its quality. The heat of a naked fire would if great care were not taken burn the Caoutchouc; and because it is a convenient and safe method, and fulfils the desired conditions, it may have at last come to be looked upon as essential. Certain I am that it has no blackening action as is so frequently stated. That this blackening is due to atmospheric influences can be easily verified by any one taking a piece of thick Pará Caoutchouc, cutting it through so as to expose the white or yellowish white centre, and notice how soon the white will be changed to black by the influence of light and air.* The cautious application of heat especially if supplemented by the fumes of melted sulphur, which I believe is used in Pará, would and does furnish the best *prepared* Caoutchouc. Of natural heat, or allowing the Caoutchouc to coalesce and the water to evaporate spontaneously, though the Caoutchouc is in as good a condition as the tree can yield it, yet it always has masses of bark adhering to it, and necessitates a second visit being paid to the tree, and this alone is objectionable as the scene of operation has constantly to be shifted.

Of the addition of various substances such as alum and certain plants the action seems to be similar to that of rennet on casein, but I have had no opportunity afforded me of testing the precise action of these substances. The chief plant used in Nicaragua is the common *Ipomœa-nox*, L. = *Calonyction speciosum*, Choisy, a convolvulaceous plant. This was identified with the "achete" by Dr. Seemann at my instigation. The use of alum as before stated is very much used in Pará. The treatment with an acid (Acetic)? can only be put down as a conjecture at present. The action too of Liquor Ammonia is generally said to retard coalescence; whether its action be to stay this coalescence in order first to get rid of as much aqueous liquid by the difference of density I do not know. In the wet processes as distinguished from the dry methods of preparation, viz., by the addition of hot, cold, or salt water &c., they are open to the objection of retaining moisture in Caoutchouc, by the outer portions of the coalescing milk becoming first acted upon and inclosing water inside it.

Next to *purity dryness* stands as the foremost desiderata in well prepared Caoutchouc. The wet processes, particularly that with alum, is very easy of application, but the precaution should be taken to prepare the Caoutchouc in thin sheets, and subjecting them to hydraulic, screw, or other pressure.

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* Caoutchouc, like other hydrocarbons, absorbs oxygen readily, and thus undergoes the change indicated. The resins (*albine* and *fluavile*) found in gutta percha appear but to be gutta percha plus oxygen.

Purity and freedom from false packing, adulteration, and admixture of all kinds should be attended to in order to produce a good marketable Caoutchouc. Frequently one sees a parcel of Caoutchouc in which possibly are patches of sand, stone, bark, &c., and as a necessary consequence it is valued at a low price. The Caoutchouc *itself* may be very good, and if free from these foreign substances, which add weight, would fetch a much higher price. Not only has an allowance or deduction to be made for the foreign matter, for a manufacturer cares not to pay 1*s.* 6*d.* to 2*s.* for stones and sand, (even though they have the recommendation of coming from a distance, a great recommendation now-a-days,) but also for loss of time, wear and tear of machinery in cleansing it. There is beside this the loss of freight value to be thought of.

The admixture and adulteration arises from careless collection in allowing bark, &c., to fall in the milk, or fraudulently introducing it for the sake of increasing the weight; the first can be obviated by passing the milk through sieves before subjecting the milk to any further process, and while it is yet fresh. The second by refusing to receive any such adulterated Caoutchouc, if the power of refusal be possessed. The second cause of adulteration is by the admixture of the milk (very often resinous) of the trunk, or of other trees, with the Caoutchouc, and which not only is an adulteration, but frequently destroys the goodness of the Caoutchouc altogether, causing it to become "heated" and spoiled. This should be guarded against, and after a little experience such admixture can be detected in the milk or prepared Caoutchouc. To guard against careless or fraudulent adulteration it is important that the best *form* in which the Caoutchouc can be prepared should be considered. Large masses of even good Caoutchouc *never* will fetch so high a price as small pieces as in the latter case the chance or *facility* of adulteration is reduced to a minimum. The Caoutchouc should be prepared in thin separate sheets or cakes not more than one or two inches thick, and if moulds are used, wooden ones of the shape of a child's battledore would be the best form.

These remarks will apply equally to the case of any introduced species.

MR. BRANDIS ON RUBBER IN INDIA.

From the Liverpool and London price lists for 1871-72 given in Mr. Collins' report, it appears that the principal descriptions may be classed as follows with regard to price and quality:—

Name of article, and country whence obtained.	Name of plant yielding it.	Price paid for last Parcel.			
		Lowest.		Hightest.	
		s.	*d.*	*s.*	*d.*
Pará (Pará and Amazonas)	Hevea sp.	2	8	3	1
Madagascar	Vahea sp.	1	10*	2	4½
West India (Central America)	Castilloa elastica	1	11½	2	3½
Carthagena	Do.	1	10	2	3
Guayaquil (pressed)	Do.	1	7½	2	3
Singapore (India Archipelago)	Ficus sp.	1	10½	2	3
Assam	Ficus elastica	1	4½	2	3½
Ceará (Ceará in Brazil)	Hevea sp.	1	10	2	1

* Madagascar Caoutchouc is a very superior article, which has recently only become known in this country, the lowest price quoted was early in the year, before it became appreciated.

† Price of a parcel of Assam of great purity.

The African rubber (Landolphia) varies exceedingly in price and quality, and the Borneo Caoutchouc, the produce of Urceola elastica, is only quoted a, 1*s* 7½*d* to 1*s* 10¼*d* per lb. Assam rubber stands low in the list at presentt but there seems good ground to believe that this is mainly due to the large proportion of impurities (bark, sand, stones) with which it is commonly mixed. The Caoutchouc which was collected and prepared by Messrs. Martin, Richie and Company of Tezpore, while they had the lease of the Caoutchouc forests previous to 1865, and which was known in the London market under the name of fine slab Assam, was a very superior article, and quite lately an improvement has again taken place in the quality of the Assam product.

Mr. Mann specially insists on the following points being observed:—

1. Fresh cuts to be made only in February, March, and April, and the trees to have rest for two years between each tapping.

2. The cuts to be at least 18 inches apart, to penetrate into the bark only, not into the wood, and to be made with an instrument more suitable than the others at present used. Mr. Mann prefers the German timber scoring knife.

3. As far as possible the milk to be collected in a fluid state in narrow mouthed rattan baskets, and to be brought to central manufactories.

4. Endeavours to be made to convert the milk into a solid state by a process of slow drying similar to that practised in Pará.

5. In case this method should not succeed, then the process employed by Messrs. Martin and Richie to be followed.

6. Those varieties of Caoutchouc which dry naturally on the tree, to be collected with care, and to be picked so as to get rid of all impurities.

Under all circumstances should plantations of the Ficus elastica be commenced at once in Assam on a large scale. The tree strikes readily from cuttings, its cultivation therefore is easier than that of most other trees. In one of his first reports on the subject Mr. Mann suggests that lines be cleared through the forest and that cuttings, as large as possible, be planted at convenient distances on either side of these lines. Very likely this will be a good plan to commence with, and as the carriage of big cuttings over long distances would be expensive, nursery beds should be prepared and enclosed for the growth of such cuttings from small slips.

D. BRANDIS.

MR. THOMAS CHRISTY ON INDIA-RUBBER.

Good rubbers and Gutta-perchas are sure to be in demand, and I am actively searching for new varieties, and testing the gum taken from the trees in their native countries.

One of the plants sent over as Landolphia turns out to be *Tabernœmontana Crassa*, a new variety from West Africa hitherto unknown as a rubber-yielding plant. This variety will have to be cultivated by seed or by cuttings.

According to Hecht, Levis and Kahn's Report for 1879, 25 tons of Ceará Rubber and 900 tons of African Landolphia Rubber were imported into England, while London imported some 350 tons of Assam *(Ficus Elastica)*, 250 tons of Borneo (*Willughbeia*), 550 tons of Mozambique (*Landolphia*) Rubber. By this it will be seen that next to the Pará Rubber, of which 6,651 tons were imported, the Landolphia Rubber occupies the first place, while the Ceará, owing, no doubt, to the severe drought which has been prevailing in that district, only returns about 25 tons as imported into England; but I have no doubt that if this variety is well cultivated in Ceylon and other rubber growing countries, that its returns will rival with those of other rubbers.

The Mangabeira will be another favorite variety of rubber tree, and it has not suffered by the drought. The fruit carries well, even to Europe, so it will be an acquisition in Ceylon.

The small-leaved rubber plant I received from East Africa, and which is growing in Ceylon, is easily propagated by seed and cuttings: it has not been

named, but the rubber was so much admired for its transparent appearance, that I preferred to allow the plants to go out nameless rather than keep them back for the name.

THOS. CHRISTY, F.L.S.

MALVERN HOUSE, SYDENHAM,
S. E. LONDON.

REPORT ON THE INVESTIGATION AND COLLECTING OF PLANTS AND SEEDS OF THE INDIA-RUBBER TREES OF PARÁ AND CEARÁ AND BALSAM OF COPAIBA.

(By Robert Cross.)

To the UNDER-SECRETARY OF STATE FOR INDIA.

Grove Street, Edinburgh,
29th March 1877.

SIR,

Respecting the service on which I have recently been employed in the collecting of plants yielding the Pará India-rubber of commerce, I now take the liberty to forward a detailed account of my proceedings.

On the 10th of June 1876 I left Liverpool by the "Red Cross" Steamer "Cearense," which, after calling at Havre and Lisbon, sailed direct for Pará, which was reached on the 15th of July. This city is situated on the southern bank of the river Amazon, which, at the point where it debouches to the sea, has a breadth of 33 miles. Pará is distant 80 miles from the ocean.

The population numbering about 40,000, are chiefly engaged with the despatch of import and export produce. Everything is very dear, and notwithstanding the reputed fertility of the Amazon valley, I found that nearly all the necessaries of life are imported. Thus, butter and fish come from Norway, rice and flour from the United States, while sugar, coffee, and *mandiocca* are brought from the southern ports of Brazil. Import duties are high, and so also are those on produce exported, amounting in some things, such as rubber, to 25 per cent. of the value of the article. The houses are mostly built of mud and roofed over with tiles. The windows are chiefly formed of wood hinged at the top, and push out from below, whence the inmates unseen obtain views of the street and passers by. Throughout the course of the day many of the occupants are invariably congregated behind these window lids. The great bulk of the citizens go about more ostentatiously dressed than the people of London, the attire considered essential being fine black coat and hat, with snow white ironed vest and trousers, and fancy French boots. Those who do not conform to this style of dress are stared at. Even at the beginning I did not agree with the fashion, and afterwards was farther removed from it by being almost daily bedaubed over with the mud of the *gapos*. Coloured females and slaves may be seen stepping into carriages perfectly loaded with large necklaces and glittering ornaments and even the families of foreign residents are frequently dressed in the most excessive and extraordinary manner.

The phase of slavery that exists is in so mild a form that it is at first not observed. In very many instances the slaves are allowed to hire themselves out on condition of paying their owners a certain sum of their daily earnings. The whole system is evidently dying out more rapidly than the Government laws enacted for its abolition require it to do.

Merchandise and other effects are removed from one place to another in the old primitive way, thus employing many hands, who earn high wages, Emigrant Portuguese, of whom there are about 5,000, are mostly the carriers, boatmen, and shopkeepers of the place. The supply of water of the city is carted through the streets in barrels, and sold at the rate of three-halfpence

per *poto*. The *poto* contains 21 English imperial pints. Within 12 hours after being deposited, the water is found to precipitate a greenish substance amounting to nearly one-fourth the quantity, which is not removed even if filtered through several folds of stout cloth. In the courtyards of the majority of the houses are open cesspools, which in such a glowing atmosphere may assist in developing much sickness. Dysentery, yellow fever and various other forms of a typhoid character appear to be permanent, although of late there have been no serious outbreaks, and the place is reported more healthy than formerly. Tetanus and other forms of nervous affections are of frequent occurrence, especially among the native born population. I have no doubt that Pará is far more unhealthy than any city in India. It may not be so naturally, but by a combination of circumstances; such I believe to be the case.

I found on arrival, after considerable inquiry, that the great field for caoutchouc collecting was the province of Pará, and the islands which are scattered over the lower portion of the Amazon river. Chief of these is the island of Marajo, which is about the size of Holland. A good deal of the rubber from the Rio Negro, Madeira, and other tributaries, appears to come in the form of "negrohead," or *sernamby*, while the Pará region seems to produce to a greater extent the finer kinds of smoked biscuit rubber; the preparation is attended to more carefully, besides which the Pará tree is reported to be a different variety. Its milk leaves no very prominent stain on the hands or clothing, while the milk of some of the varieties of rubber of the Upper Amazon gives a black ink-like mark to the hands and clothes of the collectors. Black rubber is stated by some to be deficient in recoil or elasticity. In order to form and establish a collection of plants, and for the purpose of making the various observations on the soil, climate, and mode of collecting and preparing the rubber, it was necessary to obtain a place to live in while so employed. Everyone told me I would experience great difficulty in finding a dwelling, and this proved true. After travelling round Pará, and searching for about eight days, I succeeded in hiring a house, but at a very high rate, as the place was large and adapted for a family with attendants and slaves. However, it was secure and offered every facility for my various requirements, which was important. My next work was to examine the district where the rubber trees grew. Mr. Henderson, who was known to Dr. Spruce, kindly introduced me to an old rubber collector, called Don Henrique, who undertook to lead the way to the *seringal*, as the rubber locality is termed, but after disappointing me twice, I resolved to lose no more time, and procuring from him the services of a lad as guide, I commenced to inspect the forest. On the 25th of July I made a preliminary journey to the region where the trees were wrought.

The land around Pará, including where the city stands, rises from the banks of the river southward in the form of gentle undulations, indented, however, in many places by deep gully-like natural ditches, called *gapos*, which often penetrate for many miles into the interior of this vast forest region, and are filled daily by diurnal tides. To those navigable by canoes or sailing craft the term *ajarape* is often applied. The intervening land between the *gapos* is frequently flat and moist, and owes its origin first to tidal deposits, and afterwards is raised higher by the decayed remains of successional rank growths of vegetation. On the elevated lands beds of white sand 20 feet in depth are met with, covered with a layer of decayed vegetation. At a similar level to this we find a deposit approaching to clay or very fine sand and mud, with here and there masses of sandstone or granite cropping out. In every direction where a view can be obtained, the country is seen to be covered by dense exuberant forest. Leaving Pará, I travelled over the high ground for several miles, until the primitive forest was reached, and then went down towards the *gapos*, following through the wood a path used by the caoutchouc collectors, we soon came to a large tree in a state of decay, which had been tapped many times. At first sight I felt extremely puzzled and perplexed at the appearance it presented. From the ground up to a height of 10 or 12 feet the

trunk was one swollen mass of warty protuberances and knots, covered with thick scales and flakes of hard dry bark.

This singular state of growth, the result of the practised system of tapping, has not yet been recorded by any one, and so was to me unexpected. A few minutes of careful examination soon showed the real cause of these deformities. The collector makes use of a small axe-like implement an inch broad. At each stroke he cuts through the bark and into the wood for fully an inch. Hundreds of these are made in the wood of each tree in the course of a few years; and cannot heal under any circumstance; but a layer of wood is formed over the injured part, at the expense of the bark, and general vitality of the tree. The newly-formed wood is again cut into and splintered and so the process is repeated on each successive layer until the trunk becomes merely a mass of twisted wrinkled wood with very thin insipid bark. In this condition hardly any milk flows from the cuts, and although for years a few green leaves may continue to sprout from the points of the twigs, yet the tree may be considered as dead, and, in fact, finally withers away. It is, therefore, the injury done to the wood, and not overtapping which lessens the flow of milk and ultimately causes the death of the tree*. The cuts in the wood are of course unnecessary, since the milk is met with only in the bark. The healing over process which afterwards takes place is similar to that seen where a branch has been lopped from a trunk. The wood is compact and rather hard, and for this reason the tree lives on for a number of years, although cut and hacked every season; but the flow of milk becomes so lessened that many are practically abandoned for years before they die. This and several large adjoining trees were growing in moist deep heavy soil of a fertile character, but quite out of the reach of any inundation.

On the 2nd of August I went in search of plants and descended to the region of the *gapos*. It had rained a good deal previously, and the collectors' footpaths were ankle deep with mud. After wading several little pools, we came to a deep *gapo*, into which the tide flowed. It was connected with many lesser watercourses that formed a kind of network, extending over a wide district of forest-covered country, the more elevated parts of which were raised only from three to four feet above the highest tides. A considerable number of rubber trees grew along the margins of both the larger and smaller streams, intermixed with cacao and forest trees. Three were observed, the base of the trunks of which were flooded to a height of one foot, yet the roots seemed to run up to the brow of the bank, and no matted rootlets were observed as is the case with the willow tree when growing on the margin of a rivulet. Most of the others occupied dry situations. Those *gapo* ditches were lined with soft rich mud, without doubt possessing great fertility. The exhalations from such places, shrouded by a forest growth of 80 or 100 feet high, were sensibly felt, and on nearly every occasion when I visited those localities I experienced slight attacks of fever afterwards. The collectors, also, during the working seasons are often indisposed from the same cause. Although the forest was excessively damp, yet tapping was being carried on, as a man was seen mixing up some clay at the side of a *gapo*. A number of good plants were met with beneath the oldest trees. The seedlings did not usually grow in any place where the ground was covered by more than two or three inches of water at flood tide. However, by far the greatest number were met with on sites above the reach of the highest tides. I measured a few of the largest trees, all of which had been tapped for periods varying from 5 to 15 years. Those found growing in shallow *gapo* ditches are preceded by an asterisk. The circumference of each one yard from the ground was as follows:—

* This applies to other kinds too, I persume, besides, the Ceará.—*A Ceylon Planter.*

		Ft.	In.			Ft.	In.
No. 1	...	6	9	No. 7	...	4	0
No. 2	...	6	10	No. 8	...	5	10
No. 3	...	4	7	No. 9	...	4	0
No. 4	...	3	0	No. 10	...	4	6
*No. 5	...	5	10	No. 11	...	4	8
No. 6	...	5	3	*No. 12	...	2	8

Most trees occurring within the limits of the worked districts are tapped if possessing a diameter of six or eight inches. Regularly tapped trees, as a rule, do not exceed 60 feet in height.

August 7th.—I went in search of more plants, and on the 10th made another collection. About 2,000 in all were obtained, but a number had to be rejected. I had cases previously made so that I was able to plant the plants in them without delay. The soil consisted of decayed leaves brought from the forest. The rougher portion was charred and put in the bottoms of the cases to serve as a sort of drainage. Then a layer mixed with some wood ashes was placed above the plants planted therein. Four cases, containing upwards of 1,000 plants, were finished in this way, one being reserved for copaiba or any other sort of rubber plants I might meet with. While the plants were being established I commenced a series of experiments, in order to ascertain how the tree might be readily multiplied in a simple rough way by any person not specially acquainted with the principles of propagation. Two separate beds, the one of brown sand, the other of decayed leaves, were formed. The terminal portion of shoots, but with a bud at the lower end, were planted in the beds in a reclining position, with only two inches of the points above the ground. Owing to the great distance between the buds, consequent on vigorous growth, many of the cuttings were a foot or more in length. At the same time a number were set deeply in an open vessel containing only rain water. The cuttings in the sand bed were the first to grow, and soon made strong shoots and root fibres. Those in the leaf mould pushed more slowly, but developed green leaflets of great substance. The cuttings placed in the water had a small portion of tap-root at the base, as the object was to dertermine if the roots would actually develope in water alone. Within 14 days these plants had several roots formed, and one or two rather weak growths came up, but a few days after I had thrown into the water some burnt earth and wood ashes the increase in vigour was very apparent. After these experiences, I felt convinced that the Parâ rubber tree delights in abundance of moisture and rich fertile deposits.

Method adopted in tapping the trees.—When the plants were somewhat established I resolved to examine attentively the process of tapping as practised by the caoutchouc collectors. In the investigation of the subject I travelled over a very wide extent of flat forest country, much divided by miry hollows and tidal *gapos*, which stretched along the bank of the river Guamá. Although this river is at least three times as broad as the Thames at London Bridge, it is not to be seen on any ordinary map. In the region alluded to there were hundreds of trees wrought by different collectors, each of whom had a separate piece of land to work on. When on these excursions, I had to go away from my place of abode at about three o'clock in the morning, as I had some miles to travel over paths not always in good condition, and it was necessary to be as near as possible to the spot where the tapping operation was performed, because the collectors begin to work immediately at daybreak, or as soon as they can see to move about among the trees. They say the milk flows more freely and in greater quantity at early morn. I do not attach much importance to this statement, but I have recorded it. Another and more probable reason is, that as rain often falls about two or three o'clock in the afternoon the tapping must be done early, as in the event of a shower the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a certain number of small cups of burnt clay. At

the lesser trees only three or four are put, but at the larger ones from eight to twelve are deposited. The footpaths leading from tree to tree are likewise cleared of sapline growths, and the bridges over the *gapos* formed at each place by the trunk of a tree are, where necessary, replaced. On proceeding to his work the collector takes with him a small axe for tapping, and a wicker basket containing a good-sized ball of well wrought clay. He usually has likewise a bag for the waste droppings of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and form the "negrohead" of the English market. The cups, as already stated, are of burnt clay, and are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily when with a small portion of clay they are pressed against the trunk of the tree. The contents of 15 cups make one English imperial pint. Arriving at a tree, the collector takes the axe in his right hand, and, striking in an upward direction as high as he can reach, makes a deep upward sloping cut across the trunk, which always goes through the bark and penetrates an inch or more into the wood. The cut is an inch in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down he takes a cup, and pasting on a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time the milk, which is of dazzling whiteness, is beginning to exude, so that if requisite he so smooths the clay that it may trickle directly into the cup. At a distance of four or five inches, but at the same height, another cup is luted on, and so the process is continued until a row of cups encircle the tree at a height of about six feet from the ground. Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by nine or ten o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours or perhaps longer. I may state that there is a great difference among collectors in the performance of those duties. Some take care to get good clay previously and incorporate it well, so that a very small portion is needed to lute the cups to the trunks; they also work with neatness and intelligence, and invariably collect a good quantity of milk. Others, again, do not take the trouble to prepare clay beforehand, but merely scrape up a handful when they require it at the side of a *gapo* which is often of little consistence, so that a large quantity is required to fasten the cups. This class of collectors have often many fragments of clay or other impurities in their milk, the result of not following a proper method of working. The quantity of milk that flows from each cut varies, but if the tree is large, and has not been much tapped, the majority of the cups will be more than half full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapo* or dry land, many of the cups will be found to contain only about a tablespoonful of milk, and sometimes hardly that. On the following morning the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made from six to eight inches lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from a tree is great, two rows of cups are put on at once, the one as high as can be reached, and the other at the surface of the ground, and in the course of working, the upper row descending daily six or eight inches, while the lower one ascends the same distance, both rows in a few days came together. When the produce of milk diminishes in long wrought trees, two or three cups are put on various parts of the trunk, where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of overtapping, as some have stated. Indeed, I do not believe it is possible to overtap a tree if in the operation the wood is not left bare or injured. But at every stroke the

collector's axe enters the wood, and the energies of the tree are required in forming new layers to cover those numerous wounds. The best milk-yielding tree I examined had the marks twelve rows of cups which had already been put on this season. The rows were only six inches apart, and in each row there were six cups, so that the total number of wood cuts within the space of three months amounted to seventy-two. It grew close to a *gapo* only eight inches above high-tide mark, and being a vigorous tree, the cups were usually well filled, but with two years or so of such treatment the tree would probably be permanently injured.* It has been supposed that the quality of the milk is better in the dry season than during the rains. Such is the case with some vegetable products, but, as regards india-rubber, there ought not, I think, to be any appreciable difference. In the rainy season the milk probably contains a greater proportion of water, but, on the other hand, I am of opinion that then a larger quantity of milk flows from the tree. No doubt the dry season is the most suitable for caoutchouc collecting, although, wherever a plantation is formed with preparing house, convenient tapping may certainly be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. In order to ascertain this, a number of very careful experiments would require to be made, extending over one or two years. Even if such an assertion was found to be true, it would probably make little difference, as tapping will have to be carried on when circumstances are most favourable.

There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree is cleaned off to a height of about three feet. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half or the entire circumference. Cuts are thickly made in the bark above this, from which the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by finding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk might escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of "negrohead," the result of the distance the milk has to run, and to the large quantity of clay employed in the process.

Collection of the Milk.—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or forefinger over the bottom to clean out some which otherwise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off and classed as *sernamby*. The cups on being emptied are laid in a little heap at the base of each tree, to be ready for the following morning. The trees occur at various distances from 10 to 100 yards apart, and as I travelled over the intricate network of muddy footpaths, I continually felt perplexed and surprised that the natives have not yet seen the advantages that would be derived by forming plantations, whereby more than twice the quantity of caoutchouc might be collected in one-fourth the time, and at for less cost and labour.

Method of preparing the Rubber.—The collectors of the region I visited, resorted with their milk to a large shed situated on the bank of the river Guama. Here were quantities of various species of palm nuts, representing an *Attalea* and *Euterepe edulis*, stored in heaps, and several jars for the preparation of rubber. These jars were 18 inches high, and the bottoms were broken out. At the base they were 7 inches in diameter, bulging out in the middle to 12 inches, and were narrowed at the mouth to a breadth of 2 inches. Each per-

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* 72 cups, say three-fourths full, would give about $3\frac{1}{2}$ pints of milk.—*A Ceylon Planter*.

son wrought on his own account, and so small jars were employed, but where a number of men are collecting for one master much larger jars are in use. The milk, on being put into a large flat earthern vessel, is put down on the floor in a convenient place. Adjacent thereto the jar is sat on three small stones, which rises it to 1½ inches above the floor. The narrow space between the base of the jar and the floor allows the air to enter, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts are put on, then some more wood and nuts alternately. These are dropped in at the mouth of the jar until it is filled to within four inches of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon this is the article most frequently used if there is much milk, and when the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish until the drops fall, then quickly places the flat side two inches above the jar mouth, and moves it swiftly round as if describing the form of a cipher, with his hand, so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk on the mould on being held over the smoke immediately assumes a yellowish tinge, and although it appears to be firm on being touched, is yet found to be soft and juicy, like newly curdled cheese, and sweating water profusely. When layer after layer has been repeated, and the mass is of sufficient thickness, it is laid down on a board to solidify, and in the morning is cut open along the edge on one side and the mould taken out. Biscuit rubber, when fresh, is often four or five inches thick. On being hung up to dry for a few days, it is sent to market. When I saw the process of smoking the rubber performed, as just described, I was considering the statements of Keller, and other travellers who write on this subject, all of whom seem to believe that the smoke from the palm nuts possesses some peculiar or strange property by which means the milk instantly coagulates. But on one occasion, when the collector was commencing to smoke some milk, I saw him wait for a short time, during which he put his hand repeatedly to the mouth of the jar, and soon learned that he could do nothing until the smoke was hot. The dense white smoke rose abundantly, but the milk would not thicken on the mould. After a little while the jar became heated, and the operation went on quite satisfactorily. I put my hand above the mouth of the jar, but could not bear the heat scarcely a second, and although the temperature of the smoke was apparently less than boiling water, yet I judged it must have been at least 180° Fahrenheit. Therefore the rapid coagulation of the milk is simply produced by the high temperature of the smoke. I have to doubt that with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. The finely divided particles of soot which forms a large proportion of the smoke undoubtedly absorbs a considerable amount of moisture, although at the same time it must be looked on as an impurity. I have no hesitation in giving my opinion that equally as good rubber could be prepared by putting the milk in shallow vessels, and evaporating the watery particles by the heat of boiling water.*

Temperatures of the Pará Rubber district.—The region of the Pará rubber tree has a sustained high temperature, a fact which has already been remarked by Dr. Spruce and other travellers. The lowest I could record was 73°, but

* A most tedious operation and one which will most assuredly be improved upon when the Pará rubber is extensively cultivated in Ceylon.—*A Ceylon Planter*.

Mr. Handerson assured me he had frequently seen it down to 72°, and I have the statements of another observer, on whom I could rely, that on one occasion the thermometer fell to 65°. The place, however, where this observation was made was fully 100 miles to the westward of Pará. In the neighbourhood rubber trees abounded.

Sites, propagation, and planting in India.—The sites most suitable for the planting of this tree will be found in the hottest parts of India. The flat, low lying, moist tracts, lands subject to inundation, shallow lagoons, water holes, and all descriptions of mud accumulations, miry swamps, and banks of sluggish streams and rivers, will be found best adapted. The tree will also grow perfectly in deep humid land, fitted for cane or coffee planting. The Malay peninsula, Burmah, the island of Ceylon, and the southern portion of India on to about as far north as 20° north latitude, should possess many localities proper.

The temperature of rain-water varied from 74° to 75° for planting. But in no place would I recommend the formation of a plantation where the thermometer at any time falls below 60° Fahrenheit.

It seems to me that the propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within three inches of the point. That portion above ground should rest on the earth on one side to its termination, so as not to suffer during hot sunshine. In all stages the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open places, in the richest dark loam capable of producing a luxuriant rank crop of sugar cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting a handful of wood ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly felled piece of forest. If the wood is allowed to rot before burning, almost the whole of the fertilizing principle will be found to have vanished. If stored in a damp place the value of the product is diminished. For planting on inundated lands the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower ends of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and wading into the water would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than three or four inches is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves. I would not advocate, at least for the present, the extensive planting of this tree in fertile cane-producing lands, because in such a description of soil it would not be able to complete with the Central American rubber tree, already introduced from the State of Panama, which grows rapidly to a much greater size, and yields a far larger quantity of caoutchouc. It should rather be planted in places where nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits. Above 4,000 tons of Pará rubber are exported annually.

BALSAM OF COPAIBA.

Search for plants of the tree yielding the Balsam of Copaiba Capivi, of Commerce.—I was recommended by Mr. Markham, just before leaving, to endeavour to obtain at Pará some plants of this tree, which abounds in the forests of the Amazon valley. These balsam trees have a wide distribution, and are likewise found dispersed in the forests of Guiana and Venezuela, and in the wooded littoral districts of New Granada, especially in the States of Santa Martha, Carthagena, and Panama. In those regions different species of trees varying in size and yield, furnish balsam, but all are leguminous, and belong to the genus *copaifera*. The finest sort in commerce, called by the collectors white copaiba, is met with in the province of Pará, and is shipped from Pará and Maranham. Very large quantities are annually sent to the French market.

After protracted inquiry discovered that few people really knew the tree and I was beginning to think that I might not be able to obtain any knowledge of it, when fortunately I learned where a practical copaiba collector lived. Formerly the tree might be seen growing in places easy of access, but owing to the method of collection practised it is now comparatively rare. At present a collector must make a journey, occupying several weeks, in a canoe up some of the Amazon tributaries, or penetrate into the dense forest lying between the rivers, to find any considerable quantity of copaiba.

It cost me three successive journeys on foot, occupying three days, before I could arrange with the collector. He was drinking a supply of cane rum (*cachass*), and he would not go anywhere until it was finished. Few occupations are so perilous and fatiguing as that of the balsam collector. Exposed daily to the drenching rains in the depths of the forest, with often an insufficiency of food, bitten by large formidable ants, and tormented unceasingly by day and night by swarms of mosquitoes, his life is of a wretched description. When living under these conditions the smallest scratch from the underwood is apt to become a sore, and increase to the size of a florin in forty-eight hours. On the 17th of September I left with the lad, and joined the collector at the entrance to the forest. The path led through a dense lofty vegetation, the majority of the trees being from 80 to 100 feet in height. The extremely fertile soil was of soft white sand, 20 feet or more in depth, covered by a thick surface layer of vegetable mould with which the sand was intermixed. Slight undulations were traversed, and three little running streams were crossed, none of which contained more than a mill of water. The land was everywhere quite mealy and dry, and was elevated at least 50 feet above the region of the *gapos* or tidal floods. Large black ants, some of which were nearly two inches in length, called by the natives *candela*, ran over the ground everywhere. The bite of this ant is quite as painfull as the sting of a wasp in this country. After travelling several miles we came to a balsam tree of gigantic dimensions. The saplings had been cut down around it by a person who lived some distance away, and who consequently was considered the owner. The tree appeared to be 80 feet in height, with a clear trunk of 50 feet. On account of the great thickness of the trunk, and absence of branches, no one was able to climb it. The clearing away of the underwood admitting freely air and light had induced the tree to bear seed, which, however, was just beginning to ripen. Little perpendicular rents were observed in the bark of the trunk from eight inches to a foot in length. From some of these which had occurred quite recently a little balsam had exuded, and flowed down the trunk. A diligent search for plants was made, and one small seedling was found by the collector, which I rejected, as I doubted whether it was really a balsam plant. Without much loss of time we continued our journey along a narrow path lined with tall grass and shrubs. At mid-day we came to some copaiba trees, one of which had been tapped some years ago. It had a massive lofty trunk, and wide spreading crown, and must have borne many crops of seeds, but not one plant was to be met with. A further search beneath a number of other trees which were scattered about proved alike fruitless. The collector

explained that the seeds on falling were immediately eaten up by an animal about the size of a rat. This fact fully accounted for the scarcity of seedlings. Everywhere underneath the trees a close network of little paths traversed the ground. We penetrated this day into the forest for a distance of 12 or 14 miles, and got neither plants nor seeds. I had a little fever afterwards for about a day, which, although mild, weakened me considerably. I felt that the daily exposure in the sun afterwards fed the symptoms which remained. On the 9th of October I took with me the lad, and returned to examine the copaiba tree in fruit already noticed. A number of capsules were found beneath it, but all were empty. The ground was thickly covered with the little paths of the animal which had devoured the seeds. Whilst engaged in searching about a gentle breeze of wind arose, which, moving the branches, brought down a few seeds in the best possible condition. These were carefully gathered, and in all 18 seeds were collected. Each little pod contains only one seed, which is coated over with a white wax-like substance, possessing a delicious aroma. When this is removed the seed is found to be black, and about the size and form of a field bean. The time was at hand when I purposed to leave with the rubber plants, so as to get to England before the cold weather set in, but I resolved, if possible, to see the method of tapping the trees actually performed. This operation has not yet been accurately described by any traveller and no scientific work or class book in the English language gives a correct account of the process, for which reason I take the liberty of recording my observations.

Early in the morning of the 13 October, I proceeded to the forest, accompanied by the lad and the copaiba collector. To each was assigned a fair travelling load, consisting of food or other necessities, but the most prominent object was a large tin capable of holding about 40 English pints, which the collector carried on his back. We travelled by a path to a point beyond the place reached on a former occasion, and then diverged into the forest, where there was no track of any kind. Entering on a district where the trees were an amazing height, we in a short time came to a very large copaiba tree. This, and a number of others, were previously known to the collector, who tapped one or two when convenient. I found he did not want the lad to see the largest of these trees, lest he might show them to others. On reaching the tree, he struck the trunk two or three blows with the handle of his axe, when a sort of hollow sound was produced. The grand symmetrical trunk was clear of branches to a height of at least 90 feet, above which the crown spread out flatly, the slender interlaced boughs, clothed with little pinnate foliage, forming an agreeable shade from the rays of the sun. The circumference at 3 feet from the ground was 7 feet 2 in. Several old fissures in the bark were observable, and one, which had occurred quite recently, was nearly 5 feet in length. Very little balsam had exuded. These rents are reported to be occasioned by the accumulation of oil in the tree, and that when they happen a loud report is heard.

The person who successfully taps a copaiba tree must be a skilful axeman. A chamber or cavity is cut in the trunk, not much broader than the axe, but sufficient to allow the workman to vary the course to the heart of the tree in such a way that he may not miss what is termed the "vein" or channel, usually met with near the centre, from which the balsam flows. The base or floor of the chamber must be carefully and neatly cut with a gentle upward slope, and it should also decline to one side, so that the balsam on issuing may run in a body until it reaches the outer edge. Below the chamber a pointed piece of bark is cut and raised, which, enveloped with a leaf, serves as a spout for conveying the balsam from the tree to the tin.

The collector commenced the work by hewing out with his axe a hole or chamber in the trunk about a foot square, at a height of two feet from the ground. The wood at first was white to a depth of four or five inches, when

it changed to a purplish red, very much resembling a piece of old oak taken from a peat moss or bog. The whole of the interior of the tree is of this colour. When the centre appeared to be reached, I was about to remark that there was no balsam, when suddenly the collector laid down his axe and called hastily for the tin. The balsam now came flowing in a moderate sized cool current, full of hundreds of little white bubbles possessing a pearly transparency. At times the flow stopped for several minutes, when a singular gurgling noise was heard, after which followed a rush of balsam. When coming most abundantly a pint jug would have been filled in the space of one minute. Owing to the diminished light consequent on the thick masses of foliage overhead, I could not distinguish the "vein" in the heart of the tree, but I observed a number of fissures that appeared to radiate from the centre outwards. Whilst making these observations I was surprised to see that the whole of the wood cut through by the axeman was bedewed with drops of balsam, and so also were the ends of the chips. This remarkable and important fact shows that every atom of wood in the tree contains a certain amount of copaiba. The bark did not appear to possess a particle. In the course of an hour nearly one-fourth of the tin was filled. A little roof, thatched with leaves, was placed over it as rain began to fall heavily. We then returned home. The collector considered the tin would be filled, and proposed to return for it in a couple of days. Although balsam may be seen slowly dropping from a tapped trunk for a month after it has been operated on, the common practice is to allow a tree, if it be good, only two or three hours to drain, and then to proceed to another. Occasionally large trees are met with which when tapped yield little balsam. The cause of this has not been ascertained. Trees of the largest size in good condition will sometimes yield four "potos," equal to 84 English imperial pints. A collector where trees are abundant, and with plenty of vessels, can, it is said, make at the rate of 5*l.* per day. Mr. Clough, an English missionary, in describing in a recent work* the method of collecting balsam, says that it "is obtained by making a gash in the bark of the tree, and plugging the space with cotton, to absorb the juice which exudes." I will venture to state that not a drop would be obtained by this process. Nor is the practice, as stated by some, of closing the cavity cut in the tree for a time with clay or wax, to allow the balsam to accumulate, ever resorted to. Even if tried it would not answer, for a number of reasons. Balsam, as it comes from the tree, has a powerful pungent fragrance, which is not particularly disagreeable, although on passing the doors of the houses where it is stored at Pará an odour, by no means pleasant, is experienced. Possibly some change may take place in keeping. Little, if any, care seems to be taken to preserve the commodity pure. Those who go up the rivers to collect on a large scale take in their boats all descriptions of jars and barrels which may have been imported with liquors, grease, or any kind of article. Paraffin cans are special favourites, and so are much sought for. Most of those vessels, on being emptied, are stowed away in dusty places, uncorked and uncovered, thus affording free ingress to ants, spiders, and all classes of insects. It is urged by some that balsam precipitates all impurities, but even if this were so, a better system might be adopted. As some of the seeds brought home have germinated at Kew, I may add a few remarks regarding the cultivation in India, whither a few plants should be sent when strong enough for removal. I trust care may be taken at Kew to keep this sort separate from other species cultivated there, mostly natives of the West Indies, and which, although interesting in what may be termed a "botanical sense," are of no value for the production of copaiba. The temperature required is the same as that for the Pará rubber tree, which at times is found growing beside it. Wet or marsh land must be avoided. The site should be of the best dry loam, suitable for cane or coffee planting. The

* "The Amazon, A Twelvemonth's Tour," by S. Clough.

stock for planting will have to be obtained from seeds ripened in India, so that, if a few plants can be transferred thither, they should be planted in good situations, where plenty of sunshine is admitted, in order that seed may be early produced. Seedlings may be planted tolerably thick, so as to shoot rapidly up, when they can be thinned out to proper distances.

I would not recommend the planting of these trees on a large scale with a view to early profit, as the growth would be slower than Panama or Pará rubber trees. The return would, I think, be realized in about the same time as is the case with oak plantations. However, a few hundred of copaiba trees growing on a planter's estate ought to enhance the value of it. Apart from the medicinal value of copaiba, it might be well to ascertain if it would not be equal to castor oil for lubricating machinery. The journeys relating to this work were among the most fatiguing I have experienced in these countries.

CEARÁ RUBBER.

Examination and Collection of Seeds and Plants of Ceara India-rubber.—On the morning of the 26th, I went on shore, as I wished to gain some knowledge of the method adopted in preparation and collection of the rubber exported from Ceará. I had to land from the ship in a *jangada*, which is a craft 12 or 14 feet in length, formed of moderately-sized trunks of a tree fastened together, and furnished with a mast and large sail. A piece of board a foot in breadth and four feet long is pushed down in the middle between two logs, to serve as a keel. The tree selected for those rafts has a peculiarly light wood said to be brought from Bahia or Pernambuco. With a good fair wind they are said to run sometimes at the rate of 15 knots an hour. The surf is so strong that no boat or canoe could often reach the shore safely. Even the *jangadas* are sometimes overturned, and when this happens there is a risk of getting a blow from the timbers of the raft, a danger considered greater than the sea. In the town I saw a large quantity of rubber in a merchant's store, and afterward observed that it was freely traded in by most classes of shopkeepers. I expected to have seen the tree yielding it somewhere near, but after travelling about over the sand hills and adjoining country for the greater part of the day, I returned to the ship completely tired. I was assured by a native, who said he knew the Pará Rubber tree and that of Ceará, that both were completely identical. But the great diversity in the climate induced me to think differently, and so I resolved to follow out the dictates of my own judgment, and not be influenced by any one until I could satisfy myself on the matter. Yet there was little time to explore, as the steamer was expected to leave in a very few days. Next morning an Indian from the interior happened to come on board the ship, and I took the opportunity of asking him the names of some of the villages and localities in the retired districts. I knew from previous travelling a good number of the Indian substantives, with their meanings, and this, together with further conversation, enabled me to form some idea of the character of the region where the rubber was collected. A single line of rail, formed to facilitate the transport of sugar and cotton, runs from Ceará, into the interior to a place called Pacatuba, distant about 40 miles. Contiguous are a number of large plantations with some slaves. On Sunday, October 29th, I landed with the *jangada*, and proceeded through the town to the railway station. I had previously arranged with a native to accompany me, but he did not appear, so I went off alone. Leaving Ceará, a flat parched-up region was traversed, diversified by a few undulations and moist hollows. Thorny tickets of bushes and slender trees, chiefly myrtles and legumes, overspread the country, with many groups of the carnaúba palm, *Copernicia cerifera*, rising high above the ordinary vegetation. The crowns of these palm trees waved about by the wind and visible over such a wide expanse presented an appearance extremely picturesque, whilst in the distance beyond rose a mul-

titude of conical peaks and mountains, the whole combining to form a landscape of surpassing beauty. After a journey of two hours I stopped at a little village with about a dozen thatched houses, called Maracanahu. The distance may be 30 miles from Ceará. I went to a man and boy who were standing in front of a hut, and made some proposals to them to show me the locality where the rubber trees grew. The man was advising the boy to accompany me, who seemed rather reluctant, when a poor lad who had lost an arm came up and at once consented to go with me. It was fortunate I met with this one-armed lad, as I could hardly have succeeded so well with any one else. I told him I wanted first to see trees that were being wrought, because I wished to make sure of the tree, and also observe the method of collection. We proceeded along a dusty path for some distance, at times running, as I proposed, if possible, to return with the train which passed the village in the evening. Plantation establishments were seen dispersed at wide intervals over the country. Cultivation was only carried on in very low moist situations, or where the water during the rains was stored up in aritificial ponds for irrigation. Some of these were so large that at first I took them to be natural lakes. After travelling for some time the lad turned from the path and dived into the forest. In a few minutes he brought me among a number of rubber trees which had recently been bled. The general forest was tolerably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. The soil was in places a sort of soft sandstone or gravel, which was bound up in the most extraordinary manner. Neither grass nor weeds grew among the underwood, and there was an entire absence of ferns, mosses, and other plants. I soon saw that the tree was totally different form the rubber tree of Pará, and also that it would probably thrive perfectly over a very wide extent of the drier regions of India. At first sight it much resembles in appearance a birch tree, and the surface or epidermis of the bark comes off in the same way in thin silvery peelings. The largest of the trees were about 50 feet in height, with trunks nine inches to a foot in diameter. The crown is divided into many branches, which grow in the form of a basket. The tree is deciduous, and there were neither leaves, flowers, nor fruit to be seen. I spent some time in examining attentively the process of bleeding the trees, and then commenced to search for plants. A few were found growing in an open space, but the roots were so firm that not one could be pulled up. It seemed strange that the lad and myself, exerting all our strength, could not pull up a young seedling plant about two feet high. I went and got a pointed branch of a hard wood tree, and scraped and dug about the roots, and in this way, with very arduous work, during which I hurt and lacerated my hands, some plants were got up. The real difficulty was now apparent. The roots of the plants were furnished with tubers, the largest of which were about the size of kidney potatoes. These tubers, although quite near the surface, adhered with such tenacity to the sandstone, or hard gravel, that most of them had to be smashed in order to get away an uninjured portion of root with the stem. In the young state they are soft and spongy, and are seen to contain milk, but afterwards become lengthened out, and form a part of the root. With diligent search and hard labour we succeeded in collecting 18 plants. At the station, a number of natives from Ceará gathered round the "bundle of sticks," but could not make out what they were. However, an old man from the forest district came up, and, peering through the crowd, said "Manisoba." This is the Indian name of the rubber tree, which I knew before. I got back to Ceará just before dark, and fortunately found a *jangada,* which put me on board. Thus in one day, I was fortunately able to discover the origin of a tree, hitherto unknown and undescribed, yielding an important article of commerce, and at the same time resolved the mode of collection and preparation, and secured a number of plants. It is true I had no intructions regarding this Ceará rubber plant, probably because it was supposed to be the same as the Pará tree. But I thought it would be well to secure more plants, and told the owner of the

jangada to come for me in the morning. This sort of raft was expensive, each voyage cost me three *milreis* (6*s*.), and I could not possibly have got one for less. The distance was only about three hundred yards. Next day the sea was very rough, and three *jangadas*, one of which carried the Brazilian Government mails, were overturned in the surf. The person I arranged with came for me, and I embarked. Although I was not in the least alarmed, the size and violence of the waves completely surprised me, while the *jangada* at full speed went groaning through the surf, covered by nine inches or a foot of water. I cannot help wondering that not a farthing has been spent in improving the safety of these Brazilian ports.

Returning to Maracanahu, I proceeded to an adjacent house, where I was previously told I could stay. The son of the owner assisted me in obtaining a quantity of seeds, 700 in all. The pods when ripe burst and go to pieces, and so the seeds are showered on the ground. At daybreak next day we went in search of plants. We brought a strong iron hoe, as my intentions were to take up a good number, for I did not place much confidence in the seeds, although I am glad to state they have turned out well. Our course was directed to a more distant part than I had previously visited. Shortly after entering the bush-like forest we came on a large tract of land covered by immense masses of grey granite, some of which might be 50 tons or more in weight. These had been broken were they lay, and were the result of a volcanic explosion. Rounded masses of the same rock also cropped out in many places. Travelling now became very difficult, as we had occasionally to scramble from one block to another on our hands and knees. Many good sized rubber trees were growing in the spaces between those granite masses, but no plants were seen. The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs were not perceived. After fully an hour of tiresome exploring I resolved to go back to the place where I got plants previously. We there succeeded in collecting a number, which, with those formerly gathered, amounted in all to 60. The handle of the hoe broke, for which reason the work was not further prosecuted. Taking with me the seeds and plants, I returned to the steamer in the afternoon.

System practised in Bleeding or Tapping the trees, and Collecting the Rubber.—This is an operation of a very simple description. On commencing to work the collector takes with him a stout knife, and a handful of twigs to serve as a broom. Arriving at a tree, any loose stones or dust are swept from the ground around the base, and some large leaves are laid down to receive the droppings of milk which trickle down. Some do not go to the trouble of sweeping the ground or laying down leaves, for which reason the milk adheres to sand, dust, decayed leaves and other impurities. The outer surface of the bark of the trunk is pared or sliced off to a height of four or five feet. The milk then exudes, and runs down in many tortuous courses, some of it ultimately falling on the ground. After several days the juice becomes dry and solid, and is then pulled off in strings and rolled up in balls, or put into bags in loose masses. Only a thin paring should be taken off, just deep enough to reach the milk vessels; but this is not always attended to. Nearly every tree has been cut through the bark, and a slice taken off the wood. Decay then proceeds rapidly, and many of the trunks are hollow. In this condition the tree must yield far less milk, and many, no doubt, are broken over by the wind or wither away. Collecting is carried on during the dry season only when rain seldom falls.

Climate and Temperature.—The flat country from Ceará, running back to the mountains, in which the tree abounds, manifestly possesses a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca and other crops required to be irrigated. The rainy season is said to begin in November and end in May or June. Torrents of rain are then reported to fall for several days in succession, after which the weather moderates for a brief space. According to some statements, there are occasional years in which hardly any rain falls. This assertion concurs with the aspect

presented by the country in general. The daily temperature on board the ship ranged from 82° to 85° Fahrenheit, but inland it is often probably 90°.

The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea. The situations selected for cultivation in India should possess a rather dry and sustained high teperature. In the comparatively low lying coast country ot the southern portion of the peninsula of India including the districts of Madras, Cochin, Calicut, Cannanore, Mangalore, and Bombay will be found many localities possessing all the conditions essential for the growth of Ceará rubber. The plant might likewise be tried in the deep tropical valleys of Assam, and, indeed, in all the parched regions of India within the limits of coffee planting. It may not be safe, at least until some experience is gained, to plant in any locality where the temperature at any time of the year falls below 50° Fahrenheit.

Propagation and Planting.—Seeds are early produced if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest the formation of plantations by cuttings, which will take root as easily as a willow. These should be taken from the points of strong shoots, and may be one foot in length. In planting each cutting may be put down in the soil* to a depth of six inches. If scarce the entire shoot may be cut into pieces, each possessing a bud, all of which will grow if covered with half an inch or so of soil. On loose sandy soils or exhausted coffee land, plantations may be formed at little expense. Dry hard gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper, and a stout cutting put into each and filled with pebbles. On bare or thinly covered portions of rock and cuttings might be laid down flat, and a little heap of stones or any kind of *debris* about the size of a molehill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. I do not advocate planting in an entirely barren desert, but wherever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. Ceará rubber occupies a good position in the market. The export has been stated to amount to 1,000 tons per annum.

Specimens of India-rubber.—I have forwarded to Mr. Markham the following samples of caoutchouc, No. 1, prepared as follows:—An imperial pint of rubber milk was put into a tin can previously blackened, and exposed for fully two hours to the sun during the hottest part of the day. The lid of the can was put down close. The temperature obtained exceeded 120°, but only about the half of the milk coagulated. The mass was pressed, when a whey-like juice came from it freely. It was then put to dry. No. 2 formed the remaining portion of the milk. It was put into a shallow tin vessel, and evaporated at 212°. Every drop of the milk coagulated. The entire produce of the pint was found to weigh 10 ounces. This yield exceeds any calculation I have seen on the subject, but I did everything correctly. In the process followed with No. 1 it was probably the richest portion of the milk that thickened, as may happen in the same way with various principles obtained from vegetable structure.

Nos. 3 and 4 comprise a "biscuit" and half a biscuit of rubber prepared by the smoking process as already described. These and the previous preparations are from trees whence the plants were obtained yielding the white variety. It abounds chiefly in the lower districts of the Amazon Valley.

No. 5. A choice sample of seasoned rubber kindly selected for me by Her Britannic Majesty's Consul, Mr. Green.

No. 6. This is a black sort of rubber, and in appearance agrees perfectly with a species described by Dr. Spruce, which he saw wrought on a tributary

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*** Propagating the Ceará by cuttings has been found more difficult than was anticipated. Seeds germinate readily if properly prepared.—*A Ceylon Planter.***

of the Upper Amazon. Some Pará merchants say that it is not so elastic as the white variety.

No. 7. The best kind of "negrohead" or *sernamby*, resulting from detached portions and droppings during the smoking operation.

No. 8. "Negrohead," or *sernamby*, being the gatherings from tapping cups.

No. 9. A small piece of Pará rubber, prepared by the German method with alum. A few grains of finely-powdered alum was thrown into a little milk and stirred, when it coagulated in less than a minute.

No. 10. "Mangaba" rubber, obtained from a shrub (*Hancornia* species) growing along the southern coast of Brazil.

German merchants have taught the natives to prepare it with alum. It brings a low price in the market.

No. 11. Ceará rubber of commerce now being introduced into India.*

Observations relating to the Rubber-producing Tree of Central America.—I will now add a few remarks concerning this tree, which I collected in the interior of the Isthmus of Panama towards the latter end of 1875. This, because I think it has not received the attention it deserves. There are now a good collection of plants at Kew, and I am surprised that more have not been sent to India.

The tree inhabits wooded regions near Guayaquil and Buenaventura, and has likewise been met with abundantly in the State of Panama, and in the Republics of Costa Rica, Nicaragua, Honduras, Guatemala and Mexico. It is one of the largest and most massive of the trees of western tropical America. The trunk often attains to a surprising thickness and height, yielding in some instances above a hundred pounds of India-rubber. The wood extremely soft, and when cut into decays rapidly. The destructive method of cutting down the tree to be tapped has exhausted extensive rubber localities, and although others may be opened up, yet the supply is certain to diminish at no distant date. Even where the trees are not felled, as in Nicaragua, the method of tapping, by which the wood is injured, is so unskilful that it has been considered by some as perferable to cut the tree down at once. The climate of various of those rubber districts is hostile and severe, and some places, such as the forest regions of Buenaventura and Choco, have no parallel in the universe. Throughout the State of Panama drenching rains are almost of daily occurrences and occasionally on the Atlantic side hurricane blasts make avenues in the forest.

The district investigated by me, and where the plants were collected, was reached by ascending for some distance the River Chagres, and then travelling for several miles through a stately forest into the heart of the isthmus. The trees seen exceeded in height and dimensions those met with in the wooded districts of the Amazon. An undergrowth of a thorny wild pine-apple (*Bromelia*), 10 feet in height, everywhere formed extensive thickets. Large powerful snakes were numerous, and so audacious that they deliberately rose up to strike at any one that approached. The young rubber saplings were found growing most abundantly on the banks of cool clear running streams und little dribbling rivulets. The roots could easily be traced over the surface of the ground running down to the very margin of the water. But the tree grew also on eminences, steep declivities, and varied elevations, and in such abundance that the first explorers gave the name "Caoutchouc Hill" to a height which they found crowned with a forest almost entirely composed of rubber trees. It was not seen growing anywhere on swamp or marsh land. Although the rubber districts are proverbially rainy, yet the tree was seen by me growing beside a stream on the border of a desert tract of country bounding the Gulf of Guayaquil, where only a few light showers of rain fell during the year. On both sides of the stream there was a strip of good forest, but beyond thickets of cacteæ and low spreading legumes formed the characteristic vegetation. I mention this

* Of the several samples of rubber brought out by myself from England the Para was priced the highest being 3s. 4d. per lb.—*A Ceylon Planter.*

fact to show that the tree will probably succeed well in regularly irrigated districts, even if the atmosphere be dry and dusty. The temperature in the woods of the isthmus ranged from 75° to 88° Fahrenheit. Rain water, examined the moment it fell, was never found to be below 74°. The usual practice in collecting the milk was by felling the tree, and then making deep notches around the trunk at distances not exceeding one foot apart. Broad leaves were placed beneath these to receive the milk, which afterwards was collected in a large calabash or other vessel. A hole was then dug in the ground, and the milk poured into it and thatched over with leaves. It coagulated in about two weeks. Another method was, to bruise a handful of the large broad heart-shaped leaves of a climber—a species of *ipomea*, and stir these about in the milk. By this operation the milk thickened in less than an hour, having the appearance of a jelly-like mass, but very porous, and exuding profusely a black ink-like water whenever touched or moved. This system of preparation produces an inferior article, and I have seen some buyers from the United States cut up the large juicy flakes into slices an inch or so in thickness, and dry them in the sun. The temperature of the sea-water along the west coast, where the rubber tree grows, is high, and does not vary much during the year. In the Gulf of Guayaquil it is usually 78°, at Buenaventura 80°, and in the Bay of Panama 79°. The water of the River Charges, although 80° in fine weather, falls during violent rains to 76°. On such occasions many fish are to be seen in certain places floating about in the water as if benumbed or dying. I do not know if this is the result of the sudden lowering of the temperature, or if it is to be attributed to the great quantity of decayed vegetable matter brought down by the discoloured swollen torrents from the interior of the forests.

In India there are many districts which possess all the climatic conditions necessary for the successful cultivation of Central American rubber. From Bombay southward the majority of the deep debouches of the Ghauts coming from the base of the western slope of the Malabar hills, including the humid forest region extending in places down towards the coast, contain many excellent sites. In Ceylon and Southern Burmah, and the Malay peninsula, the tree is likely to thrive in all proper situations. Calicut is about in the same latitude as the centre of the region occupied by this rubber tree in its wild state. The deep recesses of the Sispara Ghaut really closely resemble some of the caoutchouc districts adjoining the River Dagua. The sites selected ought to be at low elevations, and no place should be tried where the temperature at any time during the year falls below 60° Fahrenheit. Marsh land must be avoided. In dry desert localities the tree may be expected to do well when planted along the banks of canals, or any description of channels where water is flowing for the whole or a portion of the day. Trees in good situations will produce seeds early, but these will require to be planted without delay, as drying destroys their vitality. But cuttings must be resorted to first, and stout branches, cut into pieces each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceará rubber.

In the planting out of young plants, the petiole or leaf stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous and the trunk symmetrical. But if at the period of planting there is much bare stem above ground, then growth is usually slow, the plant remains "leggy" for some time afterwards, and never makes a good tree. If the plants get a little attention until they are four or five feet in height, I do not think there is any description of weeds or forest growth in India that will afterwards overtop them. The rapid growth of this tree, by which a large amount of vegetable mould is added to the soil, is an important feature. My own opinion is, that if planted in suitable places and properly wrought, it will be found to yield a larger return per acre than any other plant or tree cultivated in India.

Concluding Remarks.—In commencing the cultivation of these trees in India, it may be well to ascertain by actual experiment as early as possible the species likely to yield the largest amount of caoutchouc. It is possible that as regards quality there may be little, if any, difference in the milk of the various kinds when collected and prepared in the same way.*

As has been already stated, each of the three sorts require rather different sites, a wet or swamp situation being most natural to the Pará tree, while the moist banks of rippling streams or rivulets will be found well suited for the species from Panama. The Ceará tree is not delicate, and will grow and produce rubber in situations where other kinds if planted would be dried up. For these reasons, it is likely to prove a valuable plant in India in parched up regions and stony unproductive lands thinly covered with soil. The cup method, if employed in an extended way, may be found a convenient mode of tapping. Thus 20 rows of cups distributed over the entire trunk might be put on at one time. The earth could also be cleared away from underneath the large roots to allow of their being properly tapped. Even by the rude method adopted in South America, by which the wood is much hacked, the roots are found to yield milk abundantly at all seasons of excellent quality. But whatever method is adopted, it is evident that if care is exercised tapping may be carried on continually. The Pará tree in many localities gets no rest, except during a very "wet moon," or when the collectors are drinking *cachass*. Therefore, the idea of giving the trees one or two years rest ought not to be entertained. The Ceará method of paring off the surface of the bark might be tried on any of the sorts in dry weather. Pará and Panama trees may be tapped on attaining a diameter of say 6 or 8 inches, and that of Ceará with a diameter of 4 to 5 inches. A collector in a plantation working with cups should be able to collect easily from 8 to 10 pounds of rubber per day. On the Amazon, in newly opened districts, where the trees have not been operated on before, practised hands are sometimes able to collect from 20 to 30 pounds daily. A much greater quantity may be collected in even a shorter time on the Isthmus of Panama and adjacent regions, but then the trees are cut down to obtain the milk, a plan which it is assumed will not be followed in India. The cup process of tapping, the most general in use in the Amazon valley, is an Indian method, and is said to have been in use amongst them at the time America was discovered.

No time should be lost in reducing the milk, when collected, to a solid state, for if this matter is delayed, decomposition takes place, which furnishes much of the impurity complained of by manufacturers. If possible the milk should be coagulated on the day it is collected. The milk of some species, such as that of the Panama rubber tree, may keep for a week or more in a cool shady place, but Pará rubber milk spoils within the space of twenty hours, and gives off a most disagreeable odour. All the Pará rubber is prepared by the smoking method I have described. Where nuts cannot be easily found green foliage is used instead. The "fumes of sulphur," "ammonia," or "acetic acid" are never employed. Alum is generally used in thickening the "mangaba" milk in the south of Brazil, but it appears to destroy the elasticity of the rubber. The watery portion may be evaporated by placing the milk, in small quantities at a time, in shallow vessels attached to any simple form of hot-water apparatus. Either this or the adoption of a smoking method similar to that of Pará will probably be found the best. The material should be prepared in thin flakes about 1½ inches in thickness. Those pieces, if made square in the form of a bale, could be fastened together and covered with coarse cloth. In this way rubber would be both easily handled and stowed.

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* This is the point on which information is most wanted.—*A Ceylon Planter*.

The milk of *Messeranduba* (*Lucuma procera*), and of one or two milk yielding trees of the Amazon districts reported to be mixed frequently with Pará rubber possesses no elasticity when prepared separately.

The island of Borneo has been suggested to me as a place specially suited for the formation of India-rubber plantations. No doubt they would grow there as well as in India, but probably not any better. Although the position in point of latitude may appear in favour of Borneo as regards the Pará tree, I doubt if the climatic conditions of that island excel in any particular the southern portion of the Madras Presidency at low elevations. It must be remembered that what is termed by some the "equator of heat" is considerably to the north of our geographical equator. On the American continent it may, I think, be placed at not less than ten degrees of north latitude. In the dense forest regions of the Amazon and Panama Isthmus, the most striking feature in the extraordinary development of certain trees, occupying large space of ground, chiefly *ficus* and *bombax*, mantled by a dense profusion of leafy climbers, the trunks and branches clothed with parasitical plants. In India, as for instance in the best forest portions of the Sispara Ghaut, there are no conspicuous large trees with buttressed roots, but there is a far more even development of general forest trees, and I have no doubt if an acre of such land was cleared, and the wood thereof weighed, it would be found to equal if not exceed the product of a similar extent of ground in the wooded districts of tropical America. Apart, however, there remains a more positive proof of the capabilities possessed by the climate of Southern India. The coconut and mango trees can only be cultivated in the hottest regions of the tropics. Now I have visited places where these trees were planted by the natives, such as Jamaica, Hayti, St. Domingo, Porto Rico, Santa Martha, Carthagena, Panama, Buenaventura, Jumaco, Bahia, Esmeraldas, Guayaquil, and Pará, but nowhere was the fruit superior, nor hardly so large as the mangoes or the coconuts of the Malabar coast. For these and other reasons I have confidence that there exist the necessary conditions for the successful cultivation of the American rubber-yielding trees in many parts of India.

In conclusion, I trust the way in which I have performed these services may be considered satisfactory.

I am, Sir, your most obedient servant,
ROBERT CROSS.

EXTRACT FROM THE REPORT OF THE ROYAL BOTANICAL GARDEN, CALCUTTA, FOR THE YEAR 1880-81.

India-rubber.—The Ceará rubber-trees (*Manihot Glaziovii*) continue to grow vigorously, and a few of them are now beginning to yield seed. The demand for young plants and for the seed of this species continues to be considerable; and of all the recently-imported rubber-yielders, it is the only one that promises any kind of success in this part of India. The Pará rubber (*Hevea*) and the Madagascar rubber-vine (*Vahea*) have utterly failed. Of *Urceola elastica* and *Castilloa elastica*, two well-known South American rubber-yielders, I have not hitherto been able to get more than two or three sickly plants. Of the great rubber creeper of the East African Coast (a species of *Landolphia*) seeds have —thanks to the kind exertions of Dr. Kirk, Consul-General at Zanzibar—been received at the garden, and some of them have germinated. But I fear, even if it were to turn out to be suited to the climate of Calcutta, *Landolphia* would prove rather an unmanageable crop, for it is described to be an enormous creeper, climbing to the tops of the highest trees. With regard to all these exotic rubbers, it must be remembered that (with the exception of Ceará) they are either very large trees or climbers; and although it may pay well to collect rubber from them in their native forests, where they have grown to maturity without cost to the collector, it is quite a different matter when their planting and protection have to be paid for, and their coming to maturity has to be awaited for years.

THE INDIA-RUBBER ENTERPRIZE IN CEYLON.

(From the "Ceylon Observer," April 12, 1881.)

Very great confidence is expressed in the future of the Ceylon Rubber Enterprize. Not only does the growth of plants exceed all expectation, but the resulting produce is almost certain to be valuable if one may judge by what is said of rubber taken from other trees either indigenous or introduced years ago into Ceylon. We learn that a sample of rubber taken from a "Ficus" in the Matale district and sent to a London broker has been reported on most favourably as very suitable for commercial purposes, and worth 2s. 3d. per lb. All reports seem to agree that the demand is practically inexhaustible, provided rubber could be supplied a little more cheaply than at present, so many are the new as well as existing uses to which this product can be applied in British art, manufacturing and scientific departments.

On the other hand, the profitable nature of the cultivation of rubber trees to the Ceylon planters has been challenged for the following reasons. It has been said that Ceará rubber trees, to do them justice, ought to be planted about 20 feet apart. That would give no more than a hundred trees to the acre; but it is felt that at least 175 trees can safely be planted. The yield of rubber per tree has been calculated at four ounces of marketable produce per tree per annum. This would amount to say 44 lb. of rubber per acre, which, at present prices, might be considered the equivalent of £5 gross. No great fortune to be made out of this amount certainly, even though, as is pointed out, the cost of cultivation and collection must be very small, a mere trifle. No new product, it may be said, leaves so small a margin as this one, if the yield of four ounces per tree is a fair estimate. It is on this point, however, that we require further information.

India-rubber Seed.—The Zanzibar correspondent of the *Times of India* writing on the 5th April, reports:—

"On a recent visit to the mainland, Dr. Kirk, who is well-known as an enthusiastic botanist, has obtained specimens and seeds of the true India-rubber plant of the district, which will enable the botanical authorities in England to describe and fix the species. The seeds have been sent to the India Government at Calcutta, where the East African plant will be cultivated along with the plants already obtained from Brazil and Central America. As the East African India-rubber grows wild over upwards of 1,000 miles of longitude and extends far inland, no doubt many parts of India will be found suitable for its growth. The India-rubber plant has already been introduced at Madras by Dr. Kirk, who has also supplied the seeds from which plants are now being distributed to our tropical colonies from the Royal Gardens, Kew."

CEARÁ RUBBER CULTIVATION IN CEYLON.

("Ceylon Observer," May 2, 1881.)

We give prominence to several interesting and thoroughly practical communications addressed to us on this subject in answer to our remark on the uncertainty of the yield of produce from the fast-growing Ceará rubber in Ceylon. In the first place we have a sceptical planter asking: "Will the planting of rubber pay?" and he gives an estimate which, if correct, looks very much like a decision in the negative:—

CEARA RUBBER: WILL IT PAY?

To the Editor of the "Ceylon Observer."

Western Province, 22nd April 1881.

DEAR SIR,—I should very much like to ask a question through the medium of your valuable columns, and if you will permit me the space I will put it, and a few calculations besides. The question is, that with which I head this letter, viz., Ceará Rubber, will it pay?

I am quite open to believe that it will, if anybody will be able or good enough to prove statistically that it has, will, and does. I of course mean, as a product, *by itself.* I have taken some little trouble to go into figures in the matter, and the conclusion I arrive at is far from satisfactory to my mind, and, unless some other calculation can be shewn with a better result, I greatly fear Ceará rubber is not to be the Eldorado that some may fondly anticipate.

We frequently see writers in the "Planting" column speak of what a wonderful growth *has* been attained by Ceará, but what we want to see is an equally wonderful production of caoutchouc, but for this particular subject nobody will give us so much as a hint: even Dr. Trimen in his "Notes on Some Trees Yielding India-rubber" only goes so far as to say that "in Ceylon it may be confidently *expected* that they [Ceará, &c.] will become a valuable source of revenue," but there is not one word to shew how this confident expectation will be realized. No doubt, if we had thousands of acres of Ceará growing wild, and had only to pay an occasional visit with a gang of coolies, armed with Mr. Wm. Smith's cinchona scraper, then Ceará would "become a valuable source of revenue," but otherwise I don't quite see it. I estimate as follows for one acre based on the following facts:—

109 trees planted 90 feet × 20 feet=one acre.
Each tree we may *expect* to give ½ lb.
Vide Dr. Trimen's figures each lb is worth R1·25 in England.
Cost for the first three years will be as follows:—

Estimate for one acre of Ceará Rubber.

Purchase of one acre at upset price plus stamps, &c.	12·00
Felling and burning one acre of chena	12·00
Lining and holing	3·75
Weeding 1 acre for 12 months at 3s per month	18·00
Management	10·00
Purchase of seed and filing the same, 2 cents per seed ...	2·18
Contingencies 20 °/ₒ on the above	5·78
Total for the 1st year	63·71

2nd year's expenditure.

Weeding at 2s per acre per month	12·00
Management	10·00
Contingencies 10 °/ₒ on above	2·20
	24·20

3rd year's expenditure,

The same as 2nd year ... ...24·20

Dr.	Account	Current	Cr.
To 1st year's expenditure	63·71	By 1st crop ½ lb per tree=54½ lb	
To 2nd year's expenditure	24·20	at R1·25 per lb=	68·13
To 3rd year's expenditure	24·20	Balance to Dr. of 4th year	43·98
	112·11		112·11
To Balance due	43·98		

The above estimate gives nothing for cost of curing, roading, assessment, transport home, duty (if any), and interest on outlay, so not considering this the estimate must be considered as a very low one. As to the yield per tree I don't think we can well expect much more, till the tree is very much older, and, allowing for the contingencies above, I think the estimate I have given as to quantity reasonable.

With regard to curing, Dr. Trimen speaks in his "Notes" of the purtiy of the prepared rubber being "a matter of first importance," and goes on to say, that the milk should be passed through sieves, so that we may "confidently expect" that the preparation for the market will cost us something considerable. Then last, but not least, we have a vastly superior market to contend against.

If anybody "who knows" will be so good as to make his views public as to the paying question he will be granting a boon to them and also to yours faithfully, SCEPTIC.

Very much to the point also is the series of propositions laid before us by Mr. Borron, who has given considerable attention to this new product:—

To the Editor of the "Ceylon Observer."

DEAR SIR,—In its avidity for new products, it is evident that the public would like to do a big thing in Ceará India-rubber, but that its aspirations are checked by a scarcity of seed. It would be well, however, if our knowledge of the article was a little more complete, and your late leading article was well timed in preparing would-be cultivators for a possible trifling yield per tree and very low returns per acre. There are several other points, however, deserving of careful consideration:

1. We have been told that the demand for rubber is general and almost unlimited. If so, it is remarkable that while the total supply is comparatively not by any means large, yet the price seems to keep pretty steady at very moderate limits, so that it is strange the supposed large demand does not either increase supplies or raise prices. Perhaps some explanation may be found in the indestructibility of the substance enabling old used-up material to be again worked into new.

2. It is most desirable that our Botanical Garden Department should as soon as possible, by actual experiment, ascertain not merely the best planting distance for the trees, but also the probable average yield that may be reasonably expected, and the best mode of extraction. I note you adopt the distance suggested by Dr. Trimen, but I think general experience inclines to much closer planting. You mention 4 oz. per tree as the possible yield, but give no reason for saying so. The mode of extraction mentioned by Mr. Cross, the collector, as adopted by the natives. viz., that "the outer surface of the bark of the trunk is pared or sliced off to a height of 4 or 5 feet," would, if it does not lead to the death of the tree, probably preclude the securing of a crop oftener than every second year.

3. The facility of propagation and successful growth in poor hard soils has evidently been much exaggerated, and it would be well if the public were disabused on this point.

At an elevation of some 1,200 feet with a high temperature and an annual rainfall of some 70 inches, I planted a seedling in good soil slightly manured. The plant grew most rapidly and well, attaining a height of some 25 feet in about 9 months. I planted another seedling in superior but unmanured soil, and in 4 months it was over 6 feet in height and blossoming. In poorer soil I planted 3, which in about 8 months had branched freely and were over 10 feet high. In poor hard soil I planted 2, which, though healthy looking, are now, at about 9 moths old, only some 5 feet in height, while in very poor hard gravelly soil a plant of the same age was only a little over 3 feet in height and was sickly looking besides. Mr. Cross says:—"Dry hard gravelly wastes, if found to support any kind of bush, are also suitable sites." Again:— "On bare (!) or thinly covered portions of rock the cuttings might be laid down flat and a little heap of stones or any kind of debris about the size of a mole hill piled over each." I was foolish enough to sacrifice a tree to try this. Need I say, that after over a month's hot weather with some occasional good rains there are no signs whatever of a shoot, and the cutting seems to

be perfectly dried up and lifeless. The ill-success of this experiment did not encourage me to try the further recommendation of Mr. Cross, viz., that "holes might be made in stony land with an iron jumper, and a stout cutting put into each, and filled with pebbles." Such wild advice is almost enough to throw discredit upon Mr. Cross's other statements. As Mr. Cross, however, was only portions of two days in the Ceará rubber-growing district, the advice he tenders must be at second-hand only, as by his own accounts the natives generally seemed very ignorant: one would have expected more caution from a scientific man.

4. In the future cultivation of this tree, one great difficulty and loss will arise from the ravages of wild pigs, which will grub up even fair-sized trees to devour the tubers on the roots. Of the few trees I have growing on an estate not specially subject to their attacks, I have already lost two in different portions of the estate by their means, and one of the plants was over 10 feet high; while the other trees have only been secured by building walls round them. On a large scale I have had to fence in a cardamom clearing of about 140 acres to protect it from wild pigs, but India-rubber hardly promises such returns as would justify so great an expenditure. Trusting that other rubber experimentalists will favour the public with their experiences, I remain, yours truly.

A. G. K. Borron.

In answer to Mr. Borron's first remark, we may say that the consumption of rubber in the United Kingdom and Europe and North America has certainly increased very largely of recent years, but a still further reduction in price was the condition mentioned to us as preliminary to an almost unlimited demand. In 1874 the quantity imported into the United Kingdom was 129,163 cwt. worth £1,326,605, and in 1878 the import was equal to 149,724 cwt. valued at only £1,313,209. Moderate as the rate now is in the planter's opinion, the raw material is still too high it seems to admit of rubber being used so universally as it would be if large quantities could be got at a price nearer 1s than 2s per lb. This fact of lower prices being looked for, of course, strengthens the case of our correspondent's in reference to the doubt cast on the question 'Will the cultivation pay?' On the second of Mr. Borron's points we most fully agree in the special need of the Director of the Botanical Gardens following up his useful paper of practical instructions with further notes, the result of experience which, at present, he alone has within his reach. Four ounces per annum were mentioned to us by a merchant, on the authority of Mr. Forbes Laurie, we believe, as a probable yield in Ceylon; but this point has yet to be practically settled, and that there are very diverse opinions abroad among men who have given attention to the subject, may be judged from the following from one who has consulted home as well as local authorities:

I think 4 ounces of caoutchouc per tree is *far* too little to reckon on, but Dr. Trimen will settle this point very shortly. In the meantime I may mention that the *Chavannesia esculenta* (a creeper in Burma) gives 3½ lb. of rubber the 7th year, and can be tapped annually afterwards with the same result. The creeper is, I believe, a quick-growing one, but cannot surely equal the Ceará the growth of which 'passed all understanding.' The trees at Peradeniya are planted close together and in *very* poor soil. If therefore the yield is less than some expect, the facts must be taken into consideration. Given a good soil, proper elevation, and so on, I believe the Ceará tree will yield from 1 lb. to 1½ lb. caoutchouc per annum after the 3rd year, but this is of course mere conjecture: the result has yet to be proved."

We trust Dr. Trimen will lose no time in determining, so far as he can, the yield from the Ceará rubber trees. According to Cross, the trees need be only five inches in diameter to be ready to tap, and, surely, those in Peradeniya must now be much larger. If the yield is only equal to four ounces per annum, most people will consider that Ceará rubber is not worthy of atten-

tion from the Ceylon planter, more especially in view of the large additional area covered with indigenous trees reported from the east coast of Africa. When Dr. Trimen does fix a day to tap, he ought to invite representative planters to be present.

EXTRACT FROM THE REPORT OF THE DIRECTOR, ROYAL BOTANIC GARDENS, CEYLON, FOR THE YEAR 1880.

India-Rubber.—Of the three species of South American trees here in cultivation, *Manihot Glaziovii* (Ceará rubber) is still the only one which has flowered. Seed of this has been supplied during the year to the Government gardens in India (Calcutta, Saharanpore, Ootacamund) and distributed as widely as possible among the planters in the Colony, 24,550 seeds having been thus disposed of as well as 1,879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore, Mauritius, Jamaica, British Guiana and Kew, to the Acclimatization Society of Queensland, and to Mr. H. Low, H. B. M.'s Resident of Perak. Soon after my arrival at Peradeniya I wrote a few "Notes" upon these plants which were printed as a Government paper, and have been distributed with the seeds. I have also given a botanical description, with an accurate figure, of *Manihot Glaziovii* in the London "Journal of Botany" for November. This plant is now flourishing in Ceylon in suitable places, and proves very hardy; in the new estates in the Trincomalee district it is reported to be thriving, but to have shewn itself intolerant of wet. In the Nilgiris I am informed it is doing well at 2,400 feet, and Major Seaton reports from British Burmah that there are 500 and upwards set out and well established in the Mergui plantation.

With regard to Pará rubber (*Hevea brasiliensis*) its cultivation will be probably found to be satisfactory only in rich land not much above sea-level, where the temperature is high and equable and the rainfall large. At Peradeniya the trees are now making but slight progress and suffer from wind, especially in the dry north-east monsoon. At Henaratgoda their progress is all that could be wished; our largest trees are now at three feet from the ground, sixteen inches in circumference. During the year 662 cuttings were raised and distributed. *Hevea* has proved completely unsuited to the climate of Calcutta, but is doing well in Burmah and Perak. In the latter place a tree has flowered sparingly (at two-and-a-half years and thirty-five feet high): Mr. Low kindly promises seed if any ripen, but this must be a premature blossoming, for Mr. Jenman of British Guiana informs me that he has not observed trees to flower with a stem of less than ten inches in diameter.

Two plants of *Castilloa* have been sent to Calcutta. Those in Burmah are reported to be flourishing. Much better success now attends the propagation by cuttings of this fine species. Our largest trees at Henaratgoda have now a circumference of nearly seventeen inches at a yard from the ground, and the trees are beginning to take their true form.

I hope during the coming year to make an experimental trial of the yield of caoutchouc from these S. American species.

With regard to other rubber-yielding plants, we have a fine plant of a species of *Landolphia* flourishing at Henaratgoda. Several plants of this genus, all climbing shrubs, afford African rubber, which appears to be also yielded by a fig, *Ficus* (*Urostigma*) *Vogelii*. This latter, and one or more kinds of *Vahea* (not distinguishable as a genus apart from *Landolphia*) from which Madagascar rubber is obtained, have lately been imported into Ceylon by several gentlemen. Our plants of *Gutta Sanggarip* (probably *Willughbeia martabanica*) from the Malay Peninsula, sent in 1879 by Mr. Murton, are doing well.

Gutta Percha.—This valuable commodity is afforded by numerous large trees of the family *Sapotaceæ* growing in the Malay Peninsula and Islands. Of the best known and most valuable of these, *Dichopsis Gutta*, there are several

young trees in Peradeniyà and Henaratgoda, and I have during the year, through the kind exertions of Mr. Low, our resident at Perak, received a consignment of germinating seeds of the second best variety of that country. This is called "Gatah Sûndek," and Mr. Low informs me that it forms a very large tree 120 feet high, but quick growing. From specimens of the foliage and fruit sent with the seeds, it would appear (so far as can be determined without flowers) to be a species of *Payena*. This is a valuable gift, as "the Gatah trees in Perak [as everywhere else] sufficiently large to produce the gum are now very rare, and very great difficulty arises in procuring seeds or specimens." The young plants are growing vigorously in Peradeniya and Henaratgoda. The commerical necessity for a systematic cultivation of Gutta-percha yielding trees is rapidly becoming a pressing one.

THE RUBBER TREES AT PERADENIYA.

The Director of the Botanic Carden, we now (July 1st) hear, has experimented on some of his Ceará rubber trees with satisfactory results both as to quality and quantity of milk. From one tree, it is said, the yield of milk was equal to three ounces of prepared caoutchouc of very superior quality, and this quantity of milk was taken without at all exhausting the available supply.

INDIA-RUBBER AND GUTTA PERCHA.

(*To the Editor of the "Ceylon Observer."*)

LONDON, 13th May 1881.

The demand for rubber and gutta is incereasing every day. Telegraphs and telephone, cables, and many other uses demand constant supplies, which will increase. The old Indian plan can't be depended upon.

I have sought for the trees and seeds for our colonies where the supply of rubber came from. It is most difficult testing the milk to see if it has a large enough deposit of cream—if you like to call it—to make the rubber worth while collecting.

But if a poor rubber is well collected and cleaned, it will fetch a good price. Little is known yet of the best plan for taking out the elastic gum from the juice of the tree.—Yours faithfully.

THOS. CHRISTY.

NOTES ON GUMS, RESINS, AND WAXES.

BY C. G. WARNFORD LOCK.

(From the *Journal of the Society of Arts.*)

India-rubber (from *Ficus elastica*).—The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced on scattered trees. The Chardwar rubber plantation has an area of 80 square miles. The exports from Lakhimpur in 1871 were 260⅝ tons, value £8,340. Immense forests of these trees existed on both banks of the Subansiri river, and on other streams, but the reckless treatment they received from native lessees of the forest caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. The tree grows to heights of 15 to 35 feet, and its girth, when fit to be tapped, is 18 inches to 6 feet. A high yield for the first tapping of a tree is 35 to 40 lb. of rubber. It is then allowed to remain untouched for three or four years, when another collection is made, but the yield is then much less. It is estimated that the forests of Cachar could yield upwards of 2,000 cwt. of rubber annually. It is stated that the trees yield most during the rains.

Of India-rubber, 20,000,000 lb. are annually exported from Pará (Brazil), chiefly derived from *Siphonia elastica*, but a few other species are admitted. The utmost yield from each tree is one gill. In the wet season, from February to July the gum is weak, and the tapping is stopped. The trees will grow on the *terra firma* when planted, but their seeds naturally lodge in lowland swamps. Trees properly planted, and cared-for yield well in fifteen years. Brazil is being gradually cleared of its rubber; gatherers now go to the Tocantins, Madeira, Purns, and Rio Negro, and will soon clear there also. Straus's method of preparing rubber, instead of smoking, is to drop the milk into alum solution; it is stated to be superior, but it is not adopted.

India-rubber plants grow on the slopes of the Cameroons mountains (West Africa), but the people do not yet know their value. India-rubber trees abound on the River Djour, in the province of Bahrel Ghazal. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in India-rubber with the tribes to the west.

The *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, East Africa), and at Magila the rubber is made into balls for export.

The giant creeper, *Landolphia*, grows chiefly on trees near rivers and streams in Angola and the Congo. Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water From Ambriz the trade in this rubber quickly spread south to the River Quanza, where considerable quantities are exported.

Within 20 miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, East Africa) the forest becomes almost entirely formed of India-rubber vines, affording an abundant supply of fine India-rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the rubber as it issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange-like balls, it is taken to Lindi, where what is worth 7 to 8 dol. fetches 2 dol. The width of the belt is 15 to 20 miles. On the Victoria Lake (Central Africa) are one or two kinds of tree which produce caoutchouc of good quality.

Dr. Kirk has just determined, with accuracy, the plant which yields the best East African India-rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly-made road from Dar-es-Salaam, in a west-south-westerly direction, for about 100 miles towards the interior of East Africa, through the Wezamaro country; it is apparently but little affected, except in the immediate neighbourhood of the villages, by the reckless mode of tapping employed. In many parts, a native can still collect 3 lb. of rubber daily. There are five species, but only one is considered worth tapping.

Rubbers and Guttas of Borneo and Sulu.—The Kadyans and their Murut neighbours collected a quantity of gutta-percha and India-rubber in the surrounding forests. The gums are afterwards manufactured into lumps or balls, and conveyed to Labuan for sale. The gutta is obtained from four or five species of the genus *Isonandra*, all large forest trees. The trees are felled and their bark is girdled or ringed at intervals of two feet, the milky juice or sap being caught in vessels formed of leaves or coconut shells. The crude juice is hardened into slabs or bricks by boiling, and is generally adulterated with 20 per cent of scraped bark. Indeed, it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red colour is mainly due.

India-rubber in the north-west districts of Borneo is the produce of three species of climbers, known to the natives as *manoongan*, *manoongan putih*, and *manoongan manga*. Their stems have a length of from 52 to 100 feet, and a diameter rarely exceeding 6 in; the bark is corrugated, and coloured grey or reddish-brown. The leaves are oblong, green, and glossy; the flowers are borne in axillary clusters, and are succeeded by yellow fruits, of the size of oranges, and containing seeds as large as beans, each enclosed in a section of apricot-coloured fruit. These fruits have a delicious flavour, and are much prized by the natives. The stems of the India-rubber creepers are also cut down to facilitate the collection of a creamy sap, which is afterwards coagulated into rough balls by the addition of nipa salt.

The fallen gutta trees lie about in all directions in the forest, and the rubber-yielding *Willughbeias* are also gradually, but none the less surely, being exterminated by the collectors in Borneo, as throughout the other islands, and on the Peninsula, where they likewise abound.

It was formerly thought that gutta percha was the produce of only one species of tree (*Isonandra Gutta*), but that obtained from the Lawas district is formed of the mingled saps of at least five species, the juices of a *Ficus* and of one or two species of *Artocarpea*, being not unfrequently added as adulterants. The Bornean *gutta soosoo*, or India-rubber, again is the mixed saps of three species of *Willughbeia*, with the milks of two or three other plants surreptitiously introduced to increase the quantity.

The gutta trees are slow to attain maturity, and are difficult to propagate, except from seed. The *Willughbeias*, on the other hand. grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation; hence these are especially deserving of the attention of the Government of India, where they may reasonably be expected to thrive.

There are, doubtless, yet many thousand tons of rubber and gutta in the Bornean woods, but as the trees are killed by the collectors without any thought of replacing them, the source of supply must recede constantly farther from the markets, and prices will rise in consequence. The demand for India-rubber from Borneo is of quite recent growth, yet in many districts the supply is already practically exhausted.

In Assam, Java, and Australia, rubber is afforded by *Ficus elastica*, which is cultivated for the purpose. There are many milk-yielding species of *Ficus* in the Bornean forests which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the bread-fruit family also deserve examination, as an excellent India-rubber is derived from *Castilloa elastica*, a South American plant of this order.

INDIA-RUBBER IN HONDURAS.

(From the *American Exporter*.)

Mr. Floyd B. Wilson, a member of the New York bar, left here in the last steamer for Philadephia, carrying with him some very valuable concessions from this government upon which he proposes to organize a company in new York. His principal object is to gather and prepare for market the silk grass (*Pitu*), which grows wild and covers immense tracts of land in this country. His attention, as well as that of others, has also been attracted to the *tuno* tree which produces a gum about "half and half" india-rubber and gutta-percha.

The forests of Honduras are full of it, and there is no doubt about its soon becoming an important article of commerce. The tree is almost exactly like the caoutchouc, for which it is often mistaken.

The milk coagulates by heat and changes into a mass resembling curd,

which becomes hard by washing it in cold water. When immersed for a few minutes in water above 150° it becomes plastic and can be moulded into any shape, which it retains on cooling. I believe this beautiful gum is worthy of being investigated by American manufacturers, and for their benefit I will copy from a letter which I have received from a gentleman in Nicaragua on the subject:—

"Cape Gracious a Dios, June 12th, 1881.— * * * * I am buying tuno, a gum intermediary between rubber and gutta-percha. The English trade receives it in large quantities under the name of "Balata" gum, from the west coast of Africa. That indentical gum is common to all the Central American Republics, as also to a large part of South America. The trees producing it are confined within a certain distance of the Atlantic coast, climate and altitude above the sea level influencing its production. The best markets thus far are England and Germany, where it is used in certain proportions in the manufacture of submarine cables and for other insulating purposes. I shipped one lot of 4,000 pounds, last fall to the United States, but as yet I have received no returns. I understand that the manufacturers do not know what it is, and are unwilling to give it a trial. Generally the consignees of a new article are not disposed to take the necessary trouble to introduce it to the trade. As they only receive a small commission, they are not willing to spend money for advertising in scientific and commercial newspapers. In your official capacity you can benefit the manufacturers of the United States, if you can induce some of the papers having a large circulation to publish articles on the subject. I am about going to New York with another lot of balata gum, and shall make an effort to induce some manufacturers to try it. On my return here in September next I may be better posted."

The writer of the above letter is a stranger to me, but I believe that he is quite correct in his estimate of the value of the tuno or balata gum, and I do not hesitate to indorse his ideas and suggestions. I shall be pleased to send specimens for analysis and experiments to any chemist or manufacturer who may wish to give it a trial. Either the milk or hard gum can be sent. The supply of rubber and gutta-percha is constantly decreasing, as the natives kill the trees to obtain the milk: if in the balata gum a substitute should be found for either or both of the others, its value to the arts would be immense. I hope that somebody will soon give this matter the attention which its importance merits.

ROYAL BOTANICAL GARDEN, CALCUTTA.

Extracts from the Report for 1880-81 *by the Superintendent, Dr. Geo. King.*)

India-rubber.—The Ceará rubber-trees (*Manihot Glaziovii*) continue to grow vigorously, and a few of them are now beginning to yield seed. The demand for young plants and for the seed of this species continues to be considerable; and of all the recently imported-rubber-yielders, it is the only one that promises any kind of success in this part of India. The Pará rubber (*Hevea*) and the Madagascar rubber vine (*Vahea*) have utterly failed. Of *Urceola elastica*, and *Castilloa elastica*, two well-known South American rubber-yielders, I have not hitherto been able to get more than two or three sickly plants. Of the great rubber creeper of the East African Coast (a species of *Landolphia*) seeds have—thanks to the kind exertions of Dr. Kirk, Consul-General at Zanzibar—been received at the garden, and some of them have germinated. But I fear, even if it were to turn out to be suited to the climate of Calcutta, *Landolphia* would prove rather an unmanageable crop, for it is described to be an enormous creeper, climbing to the tops of the highest trees. With regard to all these exotic rubbers, it must be remembered that (with the exception of Ceará) they

are either very large trees or climbers; and although it may pay well to collect rubber from them in their native forests where they have grown to maturity without cost to the collector, it is quite a different matter when their planting and protection have to be paid for, and their coming to maturity has to be awaited for years.

MR. A. SCOTT-BLACKLAW ON RUBBERS.

To the Editor of the "Ceylon Observer."

Clifton Cottage, Dollar, via Stirling, 21st Oct. 1881.

DEAR SIR,—Your people generally make pretty good work of my letters, considering they are written rather hurriedly, and the writer has no means of seeing the proofs. I must, therefore, be to blame for a mistake in the last paragraph but one of my letters, which you kindly inserted in your paper of the 17th September. It is *Para* rubber seed I brought home two tins of, and which I sent to Ceylon on trial.

I have no doubt of *Ceara* rubber seed growing in Ceylon if it is closed in tins while in transit from Brazil to Ceylon.

They told me in Pará that *Para* rubber seed would not grow if kept for more than a month in a dry place, and my friends in Ceará told me they had tried to grow Pará rubber from seed in Ceará, and failed. I did not get much information in Ceará regarding the collecting of the rubber. I had people working with me for the three years who were Indiarubber collectors in Ceará before the famine in the years 1877-78-79. Their account agreed exactly with that given by Mr. Cross as follows:—"The collector goes out in the morning with a basketful of cups made of clay and sun-dried and some soft clay. He makes incisions in the bark of the tree, and by means of the soft clay fastens a cup to the trunk of the tree, under the cut taking care to form the soft clay at the same time into a channel for the juice to turn with the cup. He taps a great number of trees in one day. The juice is put into a large vessel and a piece of wood into the shape of an oar is dipped in it and held over a smoky fire. Dipping and drying goes on until a thick skin is formed on the end of the piece of wood; this skin is easily cut off. Some only lay bare a piece of the trunk and let juice run down outside and dry as it runs." I did not see any Ceará rubber prepared for shipment, but at Pará I saw a large quantity, of what was collected up the Amazon, of the Pará rubber. The best kind was in large sheets about three feet by two and about an inch thick. This was white and exactly like the white rubber in use when I was at school for erazing pencil marks. The rubber is all packed in large boxes of North American deal. The inferior quality of rubber is made in round balls the size of a man's head. Outside it looks good, but inside are pieces of bark, earth &c., sticking to the rubber —apparently the refuse gathered from the ground and cuttings from the corners and edges while shaping the square sheets of the good rubber. This inferior kind gets the name of "negro-head." It is also packed for shipment in large boxes, same as the square sheets.

In the collecting and preparation of rubber European intelligence will find out improved methods. Hitherto there has been no attempts at cultivation. The virgin forests have supplied it freely, and the natives cut down the trees in some parts to get at the rubber.—Yours, A. SCOTT BLACKLAW.

(From the *Tropical Agriculturist*, Nov. 1, 1881.)

CEARA' AND PARA' RUBBER SEED.—Mr. A. Scott Blacklaw writes from Dollar, Scotland:—"You will see by my advertisement that I have made arrangements for getting seeds from Pará and Ceará in any quantity. I fear, however, the Pará rubber cannot be raised in Ceylon, from seeds brought from Brazil. They say in Pará that, if the seeds are longer than a month in a *dry* place, they will not germinate. I have no doubt of the Ceará seeds growing,

if sent to Ceylon, in tins, dried from Ceará. A few bags of Ceará rubber seeds came to Liverpool, in the same steamer in which I was a passenger. I fear they will be of little use, as they were loose in bags, and of last year's picking."

THE INDIARUBBER INDUSTRY in Mozambique seems to be developing rapidly. In 1873 only £443 worth of Indiarubber passed through the Custom House. In 1876 it reached the value of £22,198, and last year, according to figures given by Mr. Consul O'Neill, it exceeded £50,000. It would seem, however, to have reached its climax until communication with the interior are properly opened up, the careless cutting of the trees by the natives having resulted in the destruction of enormous tracts of indiarubber forest.

THE RUBBER INDUSTRY IN CEYLON.

(*Ceylon Observer*, September 19th, 1881.)

Planters of Rubber of one or other kind in Ceylon are now to be counted by scores and hundreds, and we have been pressed for some time to afford them fuller information than any yet available, by republishing in pamphlet form the opinions of different authorities under the title of "All about Indiarubber." Such a compilation is in hand; but we have not concealed from ourselves the fact that cultivators in Ceylon will have to make up from their own experience a truly reliable guide for Rubber planters. All that has hitherto been written is theory, rather than practice, and in respect of the cultivation of this product, as well as of many other tropical products, to Ceylon should belong the credit of leading the way and showing the word of would-be cultivators "how to do it." By far the most practical paper that has yet appeared is that of Dr. Trimen which was included in our last Handbook. This was based partly on Mr. Cross's Report, and in some respects Mr. Cross has not been found a reliable authority by local planters. Some of his statements are now generally discredited, but, although not borne out by experience in Ceylon, they are no doubt in accordance with what is seen of the plant in its native habitat. Mr. Scott Blacklaw described Ceará rubber as a weed in the coffee plantations in Northern Brazil, and he gave a word of warning as to the value of some of the seed imported thence to England. We are glad to learn that Dr. Trimen will shortly be able to publish some more useful information for Rubber planters, the result of his cultivation and experiments in Peradeniya Gardens, and we shall endeavour to supplement the papers already available by the results so far as they can be obtained of local experience. One planter has very courteously placed his experience at our service, in the following practical form:—

"CEARA' RUBBER.—*Germinating the seeds.*—File each seed carefully on both sides, until the kernel is *just* visible. The two ends may be rounded off a little, but the operation requires care. When the filing is finished, have ready a solution of kerosine oil and water (one to ten) and immerse the seeds in it for a second or two. This prevents ants and other insects from coming near them. This operation over, the seeds should be thrown into a tin box containing some coir fibre refuse, procurable in Colombo. Cover them well over with a further supply of the same material and shut down the box. In two days' time, they will be found, on examination, to have commenced to germinate. Take them out and put them (germ downwards) into Wilton's transplanters filled with good soil, on a table, with its legs in saucers of water. Three or four days more will suffice to let the seedlings develop into nice, healthy little plants, and ten days from the date of the commencement of the operation they can be finally transplanted. When the seeds are in the box of coir refuse no water is required, and even when put into the transplanters very little moisture is needed.

"The young plants are remarkably strong and love the sun. They are, however, very impatient of moisture, and should therefore be placed under cover during a shower of rain. The filing operation may be done on a grindstone; but to ensure *perfect* success each seed should be rasped carefully with a file.

"Some planters lose as many as 60 and 70 per cent, and in one instance, which has come to my knowledge, five plants only were secured out of 300 *seeds.* I am indebted to a gentleman in Colombo for the above simple but carefully effective way of germinating the seed, and can confidently recommend its general adoption. Not a single seed need be lost if the directions are followed.

"*Planting out.*—It being important that the Ceará species of rubber should be induced to grow coconut fashion with a tall, clean stem, it will be found necessary to plant them pretty close to each other, say 500 to the acre; and, so far as my experience goes, plants grown from seed are more likely to develope into this style of three than those propagated by cuttings. This latter grow faster, perhaps, and blossom earlier—a matter of some importance in cases where a supply of seed is required; but, for a permanent plantation, I am of opinion that every tree should be raised from seed.

"Mr. Cross's statement, that the Ceará rubber may be expected to grow and flourish in soils where hardly anything else will live, is not supported by Ceylon experience. On the contrary, there is no tree I can name that enjoys more thoroughly richness of soil, and the difference between plants in good and bad land is very marked.

"*Collection, Value and Quantity of Produce.*—Nobody is yet in a position to say which is the best way to tap the tree when it reaches maturity; but, from experiments I have made, I believe it will be found impossible to improve upon the method adopted by the natives of Ceará. They bare the trunk of the tree and allow the milk to trickle down the stem. Two or three days afterwards the gum or caoutchouc is pulled off in strings and sent to the market. As may naturally be supposed, the rubber reaches England in a very impure state. Hence its value is less than the Pará kind, which is prepared with the greatest care. My reason for thinking it impossible to improve upon the native method of collection is because the flow of milk from a Ceará tree is very slow, and any other system would increase the cost, a contingency which must be guarded against. It may, perhaps, be found possible to purify the caoutchouc in Colombo before shipping it to England. Labour is cheap, and the machinery necessary for the operation is by no means complicated. As regards the yield per tree, a very small quantity will pay, provided the cost of production is restricted, and an inexpensive method of collection adopted."

The Rubber industry is yet destined to be one of considerable importance in Ceylon, and we trust to be able to aid intending planters as much as possible, by laying before them "All about Indiarubber." The title may be deemed misleading, since so much has yet to be learned about Rubber, but of course we can give only such information as is available up to the time of publication.

In this connection we may draw attention to the Papers already published (pages 393 to 399*) referring to the New Products Commission—if it may be so called. Dr. Trimen's "Memorandum on the part taken by the Royal Botanic Gardens in the introduction of Useful Plants into Ceylon" is especially interesting, and he shews there very clearly how much indebted we (in Ceylon) have been to India for the introduction of the Pará and Ceará rubbers. In such matters however, Ceylon may well be considered an integral part of India, and the authorities here ought always to be ready to reciprocate by the supply of any seeds and plants from our Gardens required by the Government of India.

INDIARUBBER GATHERING IN COLUMBIA.—An interesting account is given of this process in a report just issued by the United States Consul at Carthagena. When the hunter has found a rubber-tree he first clears away a space from the roots, and then moves on in search of others, returning to commence operations

* Of the *Tropical Agriculturist.*

as soon as he has marked all the trees in the vicinity. He first of all digs a hole in the ground hard by, and then cuts in the trees a V-shaped incision with a machete, as high as he can reach. The milk is caught as it exudes and flows in to the hole. As soon as the flow from the cuts has ceased the tree is chopped down, and the trunk raised from the ground by means of an improvised trestle. After placing large leaves to catch the sap, gashes are cut throughout the entire length, and milk carefully collected. When it first exudes the sap is of the whiteness the consistence of cream, but it turns black on exposure to the air. When the hole is filled with rubber it is coagulated by adding hard soap or the root of the mechvacan, which have a most rapid action, and prevent the escape of the water that is always present in the fresh sap. When coagulated sufficiently the rubber is carried on the backs of the hunters by bark thongs to the banks of the river and floated down on rafts. The annual destruction of rubber-trees in Columbia is very great, and the industry must soon disappear altogether, unless the Government puts in force a law that already exists, which compels the hunters to tap the trees without cutting them down. If this law were strictly carried out there would be a good opening for commercial enterprise, for rubber-trees will grow from 8 to 10 inches in diameter in three or four years from seed. The trees require but little attention, and begin to yield returns sooner than any other. Those that yield the greatest amount of rubber flourish on the banks of the Simu and Aslato rivers. The value of the crude indiarubber imported into the States annually is about $10,000,000.—London *Times*.

GUTTA PERCHA (GUTTA TABAN, &c.).

(From the *Encyclopædia Britannica*, vol xi.)

This name* is applied to the concreted or inspissated juice of various plants belonging to the matural order *Sapotaceæ*, growing in the Malay Peninsula. To what particular tree the name "gutta percha" properly belongs, there is no evidence to show; but it has been generally given to *Dichopsis Gutta* (Bently and Trimen) or *Isonàndra Gutta* (Hooker), the vernacular name of which is "taban."†

The *Dichopsis Gutta* attains a height of 60 to 80 feet, with a diameter of 2 to 4 feet. The leaves are obovate-oblong and entire, pale green on the upper side, and covered beneath with short reddish-brown shining down. The flowers are arranged in clusters of 3 or 4 in the axils of the leaves. The fruit, about an inch long, as of an ovoid shape, and is eaten by the Malays. In Siák (Sumatra) a vegetable butter is prepared from the seeds. The wood is soft, fibrous, spongy, of a pale colour, and marked with black lines, these being reservoirs of gutta percha.‡ The gutta, as it flows from the tree, is of a greyish hue, occasionally with a somewhat roseate tinge, probably, arising from the colour vessels of the bark becoming ruptured through surcharge, and their contents mixing with the gutta. This species does not furnish all the gutta percha of commerce; indeed there are other trees which

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* Gutta, or as it is variously written gutah, gatta, gittah, gattah, is the Malayan term for gum, and Percha (pronounced as in perch, *not* hard as perka), accentuated variously as pârcha, pertja, perchá, is the name of the trees; hence the term may be translated "gum of the percha tree." The old name of Sumatra was Pulo or Pulau Percha, *i. e.*, "island (Pulau) of the percha tree."

† Tuban, túbao, taban, is the name of the tree, and, according to Logan, a new word has been added to the Malay language, viz., Menaban (Men[t]aban), *i. e.*, to collect gutta taban. The greater number of Malay nouns admit of conversion into verbs by a prefix.

‡ For figures and hotanical descriptions see *Lond. Journ. Bot.*, 1848; De Virese, *De Handel in Getah-Percha*; and Bentley and Trimen's *Medicinal Plants*, part 35, p. 16 (1878).

yield larger quantities. In all there are about thirty varieties known; but some of the vernacular names in different districts may prove mere synonyms.

The geographical distribution of the trees producing gutta percha is very restricted. Gutzlaff defines the limits as 6° N. and S. lat. and 100° to 120° E. long.; whilst Captain Lingard (who has great personal experience on the subject) gives the limits as 4° N. and 3° S. lat., still further restricting the finer varieties to 3° 50′ N. and 1° S., with a temperature ranging between 66° and 90° Fahr., and a very moist atmosphere. These limits are well within the isotherm of 80° Fahr. Many of the best varieties are found only on the hill slopes at a distance from the sea-coast, each variety forming a separate grove of from 200 to 500 trees, with high forest trees above them. They grow best in a rich light loam, with a rocky subsoil.

The collection of gutta percha generally takes place directly after the rainy season, as in the dry season the gutta does not flow so readily, while during the rains ague and jungle fever are most prevalent, and the gutta is liable to be washed away from the felled trees. The yield of a well-grown tree of the best variety is from 2 to 3 lb. of gutta percha, such a tree being about thirty years old, 30 to 40 feet high, and 1½ to 3 feet in circumference. A full-grown tree sometimes measures 100 to 140 feet to its first branches, with a girth of 20 feet at a distance of 14 feet from the base, and may yield 50 to 60 lb. of gutta percha, which loses in six months about 35 per cent of its weight in drying.

The methods of extracting the gutta percha are much the same amongst the Malays, Chinese and Dyaks. The trees are cut down just above the buttresses, or *banees*, as they are called; and for this purpose a staging about 14 to 16 feet high is erected. The tools used in felling are either "billiongs" or "parangs." A billiong is a kind of axe used by the Malays in felling, building, &c. The blade is of a chisel like form, and the tang is secured at right angles to a handle by means of a lashing of "ratan" or cane. The Chinese sometimes use an axe perfectly wedge shaped. The parang looks more like a sword-bayonet, and in the hands of a Malay is a box of tools in itself, as with it he can cut up his food, fell a tree, build a house, or defend himself.

When the tree is felled the branches are speedily lopped off to prevent the ascent of the gutta to the leaves. Narrow strips of bark, about an inch broad and 6 inches apart, are then removed, but not all round the tree, as its underpart in its fall becomes buried in the soft earth, much sap being thus lost. Some natives beat the bark with mallets to accelerate the flow of milk or gutta. The milk flows slowly (changing colour the while) and rapidly concretes, and, according to its source, may vary from yellowish white to reddish or even brownish in hue. The gutta as it flows is received into hollow bamboos, doubled up leaves, spathes of palms, pieces of bark, coconut shells, or in holes scraped in the ground. If the quantity obtained is small, it is prepared on the spot by rubbing it together in the hands into a block, in one end of which a hole is made to carry it by. In this state it is known in the market as "raw gutta" or "gutta muntah." If water gets mixed with the juice, the gutta becomes stringy and is considered deteriorated, but after boiling appears quite as good. Sometimes the gutta is kept in a raw state for a month or two, and then undergoes the next step in the preparation, that is, boiling. The boiling is generally conducted in a "kwali" or pan of cast or hammered iron, of about 15 inches in diameter and 6 inches deep. The boiling is either simply with water, or with the addition of lime juice or coconut oil. If one pint of lime juice be added to three gallons of gutta juice, the latter coagulates immediately on ebullition.

On arriving at the port of shipment the gutta, before exportation, generally undergoes examination and classification into parcels, according to quality. As received in the "godowns" or warehouses it presents great diversities in condition, shape, size, and colour,—from crumbling, hardly coherent, whitish or greyish "raw" or "getah muntah" fragments, to reddish or brownish blocks

as hard as wood. Sometimes it is made up into all manner of grotesque shapes of animals, and it is nearly always largely adulterated with sago-flour, sawdust, clay, stones, &c. The Chinese are great adepts in assorting and classifying gutta, and frequently prepare from different varieties a certain "standard sample" by cutting or chopping the material into thin slices and boiling with water in large shallow iron pans, keeping the contents constantly stirred with poles, and adding good gutta percha and even coconut oil to give a better appearance. When sufficiently boiled the gutta is pressed into large moulds, and is then ready for shipment. This process of reboiling is wholly unnecessary, and in some cases is done only to get rid of stuff which has no right to be called "gutta percha."

The amount and value of gutta percha imported into Great Britain in 1875-77 were as follows.—

	1875.	1876.	1877.
Cwt.	19,686	21,558	26,359
Value	£149,684	£163,441	£238,327

The price of gutta percha ranges from 4d. to 3s. per lb., according to quality and demand.

History.—The early history of the use of gutta percha is somewhat obscure; the Malays and Chinese are said to have long known and used it. One of the earliest notices of it in England occurs in a catalogue of the collection of the famous Tradescants.* Dr. Montgomerie, a surgeon in the East India Company's service, was the first to direct attention to gutta percha as likely to prove of great utility in the arts and manufactures. Having observed the substance in Singapore in 1822 in the form of whips, he commenced experimenting with it. In 1842, being again stationed at Singapore, he followed up the subject, and his recommendation of it to the medical board of Calcutta as useful for making of splints and other surgical apparatus met with high approval. He also sent specimens, with relative information, to the Society of Arts of London, which society warmly took up the subject, and on Montgomerie's return to England in 1844 presented him with its gold medal. Some have claimed the honour of introducing gutta percha to the notice of the commercial world, for Dr. (afterwards Sir) Jose D'Almeida, who sent a specimen merely as a curiosity to the Royal Asiatic Society in 1843, but careful investigation clearly decides the question of priority in favour of Montgomerie. The Society of Arts having requested him to lay before them the result of his experiments, he delivered a lecture in the autumn of 1844, and many patents were at once taken out, the chief being those of Mr. C. Hancock, Mr. Nickels, Mr. Keene, Messrs. Barlow and Forster, Mr. E. W. Siemens, and other. After this the substance soon came into general use.*

Properties.—Gutta percha, like many other milky juices, occurs in the laticiferous tissue of the plant, which exists in greatest abundance in the middle layer of the bark. See BOTANY, vol. iv. p. 87.

* In the *Museum Tradescantianum; or, a Collection of Rarities preserved at South Lambeth, near London, by John Tradescant, . . .* London, MDCLVI., the following entry occurs (p. 44):—"VIII. Variety of Rarities.—The pliable mazer wood, being warmed, will work to any form." This museum became the nucleus of the Ashmolean Museum at Oxford. The word "mazer," variously spelt, often occurs in early English poetry, and is specially mentioned in old catalogues and wills. It is by no means impossible that mazer cups may have been made of gutta percha, as its lightness, strength, and non-liability to fracture would recommend it; and curiously enough one of the vernacular names of the tree yielding gutta percha is "mazer wood tree."

* See Collins on "Gutta Percha" in *British Manufacturing Industries* (Stanford & Co.), and the very interesting volume of *Specifications of Patents in Caoutchouc, Gutta Percha*, &c., issued by the Patent Office.

Gutta percha is resolvable into two resins, *albin* and *fluavil*. Like caoutchouc or indiarubber, it is a hydrocarbon; Soubeiran gives its composition as—carbon 87·80 and hydrogen 12·20. In commercial gutta percha we have this hydrocarbon or pure gutta, *plus* a soft resin, a resultant of oxidation of the hydrocarbon. M. Payen gives the following analysis of commercial gutta percha:—

Pure gutta (milk-white in colour and fusible), 75 to 82 per cent.

Resins soluble in boiling alcohol:—

1. Crystalbin or albin ($C_{20}H_{32}O_2$), white, and crystallizing out of the alcohol as it cools, 6 to 14 per cent.
2. Fluavil ($C_{20}H_{32}O$), yellow, falling as an amorphous powder on the cooling of the alcohol, 6 to 14 per cent.

It is thus apparent that the change of pure gutta into a resin-like mass takes place naturally if means be not taken to stop it. Many a good parcel has been thus lost to commerce, and the only remedy seems to be thorough boiling as soon after collecting as possible. It must be remembered too, that in cutting through the bark to arrive at the laticiferous vessels, many other vessels and cells become ruptured, containing tannic and gallic acids, &c., and the presence of these no doubt accelerates oxidation. In opening bottles of the milky juice a turbidity and effervescence are often noticed, owing to the formation of a brownish liquid, the colour being probably due to the presence of gallic acid. In improperly prepared blocks of gutta also, these foreign substances induce the presence of a brown fermented and putrid liquid which decomposes the internal mass. Many of these substances, being soluble in water, are removable by the process of boiling.

Gutta percha as met with in commerce is of a reddish or yellowish hue, but when quite pure is of a greyish-white colour. In this state it is nearly as hard as wood, only just receiving the impression of the nail, is of a porous structure, and when viewed under the microscope has the appearence of a series of variously hued prisms. When moulded, rolled into sheets, or drawn into ropes, it assumes a fibrous character in the direction of its greatest length, in which direction consequently it can be stretched without rupture. If however, a strip of a sheet be cut off across the fibre, it will be found that a redistribution of the tenacity of the slip takes place; *i. e.* the direction of the fibrous character is developed in an opposite direction. The electrical properties of gutta percha were first noticed by Faraday. If a piece be subjected to friction, an electric spark can be obtained. On its relative electric conductivity, see vol. viii p. 53.

At a temperature of 32° to 77° Fahr., gutta percha has as much tenacity as thick leather, though inelastic and less flexible. In water at 110° Fahr. it becomes less hard; towards 120° Fahr. it becomes doughy, though still tough; and at from 145° to 150° it grows soft and pliable, allowing readily of being rolled and moulded. In this state it has all the elasticity of caoutchouc, but this it loses as it cools, gradually becoming hard and rigid again, and retaining any form impressed on it whilst in its plastic condition. It is highly inflammable, and burns with a bright flame, dropping a black residue like sealing wax. The specific gravity of gutta percha has been variously stated at from 0·96285 to 0·99923. It is insoluble in water, alcohol, dilute acids, and alkalies, but dissolves in warm oil of turpentine, bisulphide of carbon, coal tar oil, caoutchin or oil of caoutchin, and its own oil—for it yields by destructive distillation an oil similar to that yielded by caoutchouc under the same treatment. Ether and some of the essential oils render it pasty, and it is softened by hot water, absorbing a small quantity of the water, which is slowly parted within cooling.

Manufacture and Applications.—Gutta percha, as received in England, is in irregular clumps or blocks, and is frequently adulterated with massive stones, sawdust, bark sago flour, and other foreign matters; and the first step in its

manufacture is to cleanse it thoroughly. The blocks are first sliced by means of a powerful circular wheel driven by machinery, and having fixed in it two or three strong chisel-like knives, by which it is divided into thin slices. These are placed in wooden troughs filled with water and heated by steam. As soon as the gutta percha becomes soft it is taken out in baskets and placed in a toothed iron cylinder, called a "devilling" machine, which tears it into fragments; these fall into a trough of water, and the impurities sink to the bottom, leaving the purified gutta floating in the form of a spongy mass. This mass is then taken out by means of perforated shovels, thoroughly washed in coal water, and dried in baskets. It is then packed in jacketed iron chests heated by steam, and left till it becomes soft, when it is at once removed, and kneaded or masticated by means of a cast-iron cylinder, with a movable lid and an internal revolving toothed iron axis—the result being a homogeneous dough-like reddish-brown mass. Sometimes various substances are introduced into this machine, which is called a "masticator," to increase the hardness or density of the gutta, or to colour it—such as orange or red lead, chrome, vermilion, yellow ochre, sulphur, caoutchouc, gypsum, or resin, care being taken to use such substances only as are not affected by the heat necessary in the operation. The incorporation is conducted with great nicety, as at the will of the operator, a soft and elastic or a hard and horny substance can be produced. When sufficiently masticated, the gutta is placed whilst still hot between two steel cylinders, and thoroughly rolled. By means of an endless band of felt the gutta is returned again to the cylinders, the distance between which is gradually diminished so as to compress and completely drive out any contained air from the gutta percha. There are various machines for cutting, driving bands, &c., to a uniform width, and for rounding off the edges and finishing. Soles for boots are made by cutting a long strip of the requisite width, and then passing the strip under a hollow die.

In making piping a machine is used consisting of a cylinder, with a die-piece attached of the requisite size. By means of a piston the gutta percha, which is introduced into the cylinder in a plastic condition, is driven through the die-piece, and the piston gives the inner diameter of the piping. As the piping issues from the machine, it passes immediately into a trough of water, which "sets" it and prevents it from collapsing. The value of gutta percha piping is very great: it does not contaminate water as lead piping does; it withstands insects, damp, &c., and is easily manipulated, being shortened, lengthened, or repaired without trouble or expense; and its acoustic properties have led to its employment largely in the manufacture of aural, stethoscopical, and other instruments. Gutta percha speaking-tubes are now to be seen in nearly every office. The substance too, from the fact that few acids and alkalies affect it, especially if dilute, is largely employed for funnels, siphons, and other chemical apparatus.

In telegraphy gutta percha is of the very highest importance, being a cheap, lasting, and powerful insulator, easily applied to telegraphic wires. The general method of coating telegraphic wire is by charging a cylinder with plastic gutta percha, and forcing it through a die-piece, the wire forming a central core. As the wire is drawn through this "die" or "moulding" piece, it becomes coated to the requisite thickness, and, after passing through water, it is wound on drums ready to be coated with tarred rope, and with galvanized iron wire if required for submarine cables.

The readiness with which gutta percha, whilst in its plastic condition, receives an impression, which it retains when cold, early led to its employment in the decorative and fine arts, since it reproduces the finest lines, as in the taking of moulds from electrotypes. See ELECTROMETALLURGY.

In the production of imitations of oak and other ornamental woods, gutta percha has been largely used, since by the admixture of various substances "graining" or "marbling" can be very naturally represented, and a coating of a solution of gutta percha gives a varnish of great brilliancy.

Substitutes.—Many substances have been recommended as substitutes for, or as supplementary to, gutta percha. Among these Balata gum undoubtedly holds the first place. It is obtained from the *Mimusops Balata* (Gartner), a tree found in British and French Guiana, Jamaica, &c. Prof. Bleekrod seems to have been the first to direct attention to this substance, by bringing it before the notice of the Society of Arts in 1857. The Balata gum combines in some degree the elasticity of caoutchouc with the ductility of gutta percha, freely softening and becoming plastic, and being easily moulded like gutta percha. What small parcels have been sent to England have met with a ready sale, and were remarkably pure and free from adulteration. But unfortunately, through the difficulty of collection, the occupation being dangerous and unhealthy, the supply of this excellent article has fallen off. It is procured by making incisions in the bark of the tree about 7 feet from the ground, a ring of clay being placed around to catch the milk as it exudes. A large tree is said to yield as much as 45 lb. of "dry gum." *Pauchontee*, the produce of *Dichopsis elliptica*, Collins (*Bassia elliptica*, Dalzell), is a most interesting substance, and may yet prove an article of commerce if properly treated; at present, although by heat it becomes plastic and ductile, it is brittle and resin-like when cold. The tree is found very generally distributed in Wynaad, Coorg, Travancore, &c.

Many of the euphorbias yield milky juices which have some at least of the properties of gutta percha. The chief amongst these are the cattimandoo (*Euphorbia Cattimandoo*, Elliot) and the Indian spurge tree (*E. Tirucallis*, Linn.) of India, and some euphorbias at the Cape of Good Hope. The alstonia or pala gum (*Alstonia scholaris*, R. Br.) and the mudar gum (*Calatrops-gigantea*, R. Br.), have also been recommended as substitutes for gutta percha. But the attempts made to utilize these substances have as yet been unsuccessful.

Future Supplies.—A very important matter for consideration is the question of the future supplies of gutta percha. It is after all only a spontaneous natural product. If a Malay or Chinese wishes to plant pepper, gambier, &c., he burns down a portion of the forest, and, when he has raised two or three crops, he clears a new portion, and thus finely wooded spots become denuded of trees, and covered with rank grass rendering them unfit for further cultivation. Again, to obtain the gutta percha the trees are cut down and none are planted in their stead, so that in districts where they were in abundance one or two only are now preserved as curiosities. It is a wonder indeed that a single tree is left. A writer in the *Sarawak Gazette* says, that from 1854 to 1875 over 90,000 piculs (of 133⅓ lb. each) of gutta percha was exported from Sarawak alone, and this meant the death of at least 3,000,000 trees. In fact the only thing that preserves the tree at all is that it is of no use to cut one down till it is 25 to 30 years old. Sooner or later recourse must be had to cultivation and conservation. (J. Co.)

INDIA-RUBBER IN THE UNITED STATES OF COLOMBIA.

(From the *Journal of the Society of Arts*, Dec. 2, 1881.)

A very considerable trade is carried on in Colombia in gathering india-rubber, and the trade accounts of that country show a large increase in the export of this article for 1880 over the previous year, the greater part of it being consigned to the United States. Consul Smith, of Carthagena, in his recent report, gives an interesting account of the system pursued by the rubber hunters in collecting this article, and, at the same time, calls attention to the wasteful custom they have of cutting down every tree from which they extract the rubber instead of tapping them; in this way all the trees near the rivers have been long since destroyed, and the hunters have now to go several days journey into the forests, crossing swamps and mountains before they can find the rubber and bring it out on their backs over these rough trails. Each succeeding year the quantity gathered is less, and it is a matter of surprise

that the Colombian government has not enforced its regulations against the systematic destruction of one of the most valuable forest trees. The trees which yield the largest supply flourish along the banks of the Sinu and Aslalo Rivers. The hunters before entering the woods provide themselves with guns, ammunition, flour, salt, and tobacco. The flour is made from plantains, which are cut into slices, dried and ground, and is generally mixed with corn meal; this will keep sweet for months. For meat the hunters depend upon the game they can kill. Each man starts out with his gun and macheté alone, hunting for rubber and game. As soon as a rubber tree is found he cleans a space round the trunk, cutting away all vines, under-bush, &c., and again marches off in search of more rubber trees, not returning to camp till nightfall. According to immemorial custom, a tree belongs to him who has cut round it. The hunt is continued until all the trees in the vicinity of the camp are thus secured, and then begins the work of gathering the rubber. A hole is dug in the ground near the rubber trees, unless another party is encamped near, in that case the holes are dug near the camp. The bark of the tree is first hacked with a "macheté" as high as a man can reach, the cuts being in the form of a V, and the milk, or sap, collected as it exudes, and put into the hole which has been dug for it. After the sap ceases to flow from the cuts, a pile of wood or brush is made at the foot of the tree, and the tree itself is chopped down, the branches keeping one end of the tree off the ground, and the piles of wood at the foot of the tree doing the same at the other end, thus the tree is suspended. The hunter, after carefully placing large leaves on the ground under the tree, proceeds to cut gashes in the bark throughout its whole length. The sap is collected from the tree and from the leaves placed under it, and added to the milk first collected. The sap when it first exudes from the tree is as white as milk and as thick as cream, but it soon turns black on exposure to air and light, if not properly watched and cared for. The quantity of milk which is put into one hole, depends not only in the size of the trees, and their distance apart, but also on the strength of the man who is to carry the rubber from camp to the rivers, and the track and trail he must carry it over. As soon as the milk is placed in the hole, the rubber is coagulated by the addition of some substance, such as the root of "mechvacan," hard soap, or other substances, and these cause the milk to coagulate so fast as to prevent escape of the water, which is always present in the fresh sap, and as the rubber and water will not mix, a piece of rubber coagulated in this manner is full of small cells containing water. It costs no more to make the rubber perfectly clear and transparent as amber, in which case it is infinitely more valuable, than to make it full of holes, water and dirt. As soon as all the rubber trees are cut down, and the rubber coagulated, the pieces are strapped on the backs of the hunters, by thongs of bark, and carried by them out to the bank of the river, and brought to market by canoe or raft. Consul Smith says, in concluding his report, that the importance of the india-rubber tree, in connection with the many and useful purposes to which it is now applied, can hardly be estimated, and that the attention of the planters of Colombia has never been turned to its cultivation, and he expresses an opinion that a good field for investment lies in this direction, as a plantation of india-rubber trees would prove a most valuable source of profit. There are places on the Sinu river where the trees will grow from eight to ten inches in diameter in three or four years from the planting of the seed: the trees require but little attention, and begin to give returns as soon, if not sooner, than other trees.

INDIA-RUBBER.

Under this head a great deal of space is devoted in the latest Kew Gardens' Report, to the several plants which yield the different rubbers of commerce. On the subject of the Central American rubber plant, *Castilloa*, in

Ceylon, Dr. Trimen is quoted as follows:—"Two plants have been sent to Calcutta. Those in Burmah are reported to be flourishing. Much better success now attends the propagation, by cuttings, of this fine species. Our largest trees at Heneratgoda have now a circumference of nearly 17 inches or a yard from the ground, and the trees are beginning to take their true form."

Ceara Rubber (Manihot Glaziovii), Ceylon.—Dr. Trimen says this is still the only species which has flowered. "Seed has been supplied, during the year, to the Government gardens in India (Calcutta, Saharunpore, Ootacamund), and distributed as widely as possible among the planters in the colony, 24,550 seeds having been thus disposed of, as well as 1,879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore, Mauritius, Jamaica, British Guiana, and Kew, the Acclimatisation Society of Queensland, and Mr. Lowe, Her Brittanic Majesty's Resident in Perak."

Dr. Trimen adds:—"This plant is now flourishing in Ceylon in suitable places, and proves very hardy; in the new estates in the Trincomalee district it is reported to be thriving, but to have shown itself intolerant of wet. In the Nilgiris, I am informed, it is doing well at 2,400 feet; and Major Seaton reports from British Burma that there are 500 and upwards set out, and well established in the Mergui plantation."

Jamaica.—Mr. Morris reports:—"This plant is evidently of a very hardy character, and adapts itself readily to the exigencies of culture. Plants at Castleton (600 feet) and at the Parade Garden, Kingston (50 feet) are doing well. At the former gardens, young trees, when about 9 to 12 feet high, were beginning to flower, but the hurricane deprived us of the hope of procuring seed this year. Judging by reports from South America, it is possible that tracts of dry, stony—almost worthless--lands, in the plains, may be turned to good account by means of this cultivation."

Para Rubber (*Hevea brasiliensis*).—On the cultivation of this rubber plant in Ceylon, Dr. Trimen reports that "it will be probably found to be satisfactory only in rich land, not much above sea-level, where the temperature is high and equable, and the rainfall large. At Peradeniya, the trees are making but slight progress, and suffer from wind, especially in the dry northeast monsoon. At Heneratgoda, their progress is all that could be wished. Our largest trees are now, at three feet from the ground, 16 inches in circumference. During the year, 662 cuttings were raised and distributed. *Hevea* have proved completely unsuited to the climate of Calcutta, but is doing well in Burma and Perak. In the latter place, a tree has flowered sparingly, at 2½ years old, and 35 feet high."

African Rubbers (*Landolphia spp.*).—On this point it is stated that all the present commercial sources of African caoutchouc belong to the above genus, which is a group of woody climbers, all of which probably yield caoutchouc peculiar to tropical Africa and the adjacent islands. African coautchouc comes into commerce, both from the west and the east coasts, and only one of the rubber vines is common to both. Three species of *Landolphia* are described as producing caoutchouc on the West Coast of Africa. The form in which West African rubber comes into commerce is somewhat peculiar: it is accounted for by the method of collection, which has been described as follows:—Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly, and forms a ridge on the wound, and stops its flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually by the fingers, and smeared on their arms, shoulders and breasts, till a thick covering is formed. This is peeled off their bodies and cut into small square which are then said to be boiled in water. The three species referred to above are *Landolphia owariensis*, *L. Monii*, and *L. florida*. From the East Coast of Africa four species are referred to as furnishing rubber of commerce, namely *L. florida* (before referred to on the west), *L. Kirkii*, *L. Petersiana*, new and Undiscribed species, and a species though distinct, not yet sufficiently known to admit of

scientific description. The following extract from a report to the Foreign Office by Mr. Holmwood, the Vice-Consul at Zanzibar, is descriptive of the mode of collecting the rubber:—"The process consisted in cutting clean slices of bark from the trunk and branches, from three to ten inches in length, and from ½ to ¾ inch in breadth. The cuttings were made sometimes from one side only, but generally they were scored all over the tree, about half of its bark being thus removed. The method of making the balls of rubber—which average two inches in diameter—is as follows:—A quantity of milk is dabbed upon the forearm, and being peeled off, forms a nucleus. This is applied to one after another of the fresh cuts, and being turned with a rotary motion the exuding milk is wound off like silk from a cocoon. The affinity of this liquid for the coagulated rubber is so great, that not only is every particle cleanly removed from the cuttings, but also a large quantity of semi-coagulated milk is drawn away from beneath the uncut bark, and during the process a break in the thread rarely occurs. By working hard, one person can collect 5 lb of rubber per diem, though the average is one half this amount. I was assured, however, that in the interior, where the trees were large, it is no uncommon thing for one man to collect 7, or even 9 lb. in a day. The regular season for the collection of india-rubber lasts from about the middle of May till the first week in December. This has little connexion, however, with the state of the tree, but is owing to the natives being generally engaged during, and for some time after, the rainy season in cultivating their lands."

He further reports, that in the districts of Mungao and Kilwa alone, india-rubber "has created a new trade, which finds profitable employment for all those classes whose means of subsistence came to an end with the suppression of the illegal slave trade. The total exports from these places now (1880) exceeds 1,000 tons annually. Since last season the price has risen from £140 to £150 per ton, and there seems no reason to suppose it will ever again fall to the former figure." With regard to the destruction of the rubber vines by the collectors. Vice-Consul Holmwood takes a somewhat gloomy view. He says, it is "admitted that, while three years ago the supply of india-rubber was altogether derived from the country within 50 miles of the coast, the great bulk was now procured from Mahenge and Ubena, countries distant 150 to 200 miles from Kilwa; the supply from the more adjacent districts, having, moreover, greatly fallen off, and, in some instances, entirely ceased."

Consul O'Neill more recently remarks, in his report for 1880, on the trade of Mozambique:—"It is curious to note the marvellously rapid development of the india-rubber industry. In 1873, only £443 worth of india-rubber passed through the Custom-house of Mozambique; in 1876, it reached the value of £22,198, and in 1879, it exceeded £50,000. It would seem, now, to have reached its climax, while the present rude method of collecting this produce prevails, and until communications with the interior are properly opened up, for the careless cutting of the trees by the untaught hands of the natives has resulted in the destruction of enormous tracts of India-rubber forests near the coast."

From specimens of rubber-yielding plants received at Kew from Sir John Kirk, it seems that one of the Zanzibar plants is a species of *Landolphia* hitherto unknown to science, and now proposed to be called *Landolphia Kirkii* in honour of Sir John Kirk. With regard to the mode of collecting the rubber from *Landolphia Petersiana*, Sir John Kirk thus describes it in a report to the Foreign Office:—"The mode of preparation of this India-rubber differs essentially from either of the other two kinds, the juice being here gathered in a fluid state, by tapping, and coagulated by heat, or in some other way, similar to that use in Madagascar or the Brazils. The product, however, is said to be of an inferior quality."

On the subject of Bornean caoutchouc, the Kew report says:—"The most authentic information on the caoutchouc-yielding species of North-West Borneo is aparently that contributed by Mr. Treacher to the "Journal of the Straits

Branch of the Royal Asiatic Society for July, 1879 (p. 58). He enumerates no less than eight, with the following names:—

"1. Manungan pulau (*i.e.*, Manugan proper).

"2. Manungan bujok.

"3. Manungan manga (light coloured bark).

"4. Manungan manga (dark coloured bark).

"From the above is obtained the gutta lechak or gutta susu of commerce. (*Gutta* in Malayan means gum; *lechak*, elastic; *susu*, milk).

"5. Serapit larat.

"6. Serapit pulau.

"The produce of these is only used to increase the weight of the manungans, the milk not hardening sufficiently of itself.

"7. Bertabu or Petabo pulau.

"8. Bertabu or petabo laut.

"The produce of these is no longer marketable. The different plants would appear to be accurately distinguished by the native collectors; and, if the best of them are to be sought and brought into cultivation, their precise botanical identification becomes important.

"No. 1 of the foregoing list is referred to as a new species of *Willughbeia*, the name proposed for it being *Willughbeia Burbidgei.*

"No. 2 is *Leucenotis eugenifolius*.

Nos. 3 and 4 are supposed to be species of *Willughb ia* and *W. Treacheri*, is proposed for No. 5.

"The remainder would at present seem to be undeterminable. All the above species belong to one natural order, namely, *Apocynaceæ*. Other caoutchouc yielding plants are referred to in the report, which are, however, of minor importance as compared with those just enumerated.

"Regarding the collection in Perak of *Gutta singgarip*, the produce of *Willughbeia Burbidgei*, the following description is given:—'The stem is generally ringed at intervals of 10 to 12 inches, and the milk allowed to run into vessels made of palm or other leaves, coconut shells, or anything available for the purpose; it continues to flow for some time, but after flowing for some minutes, it gets very watery and thin. One flow will yield from five to ten catties of the coagulated caoutchouc. When raw, it has the appearance of sour milk, and, to coagulate it, the natives add salt, or salt water. When freshly coagulated, it is quite white, which gradually changes to a darker colour. It keeps white inside, and, on cutting, it presents a foveated appearance, the cells containing water and salt, which have become enclosed during coagulation. In texture it is soft, very spongy, and very wet."

(From the *Gardeners' Chronicle*, December 31st, 1881.)

The way in which this remarkable tree, Ficus elastica, became known to botanists and horticulturists was very singular, as related by Roxburgh in his *Flora Indica* iii., p. 543. Towards the close of 1810 a Mr. Matthew Richard Smith, of Silhet, sent Roxburgh a vessel, there called a "turong," filled with honey in the very state in which it had been brought from the Pundua or Juntipoor mountains north of Silhet. The vessel was a common, or, rather, coarse basket, in the shape of a four-cornered, wide-mouthed bottle made of split rattans, several species of which grow in abundance in the above named mountains, and contained about two gallons. Mr. Smith observed that the inside of the vessel was smeared over with the juice of a tree which grows on the mountains. Roxburgh was therefore more anxious to examine the nature of this lining than the quality of the honey. The turong was accordingly emptied and washed out, and Roxburgh then found that it was very perfectly lined with a thin coat of caoutchouc. Young trees were speedily procured through Mr. Smith, and cultivated in the Botanic Garden at Calcutta, where they throve with the greatest luxuriance. The name only was first published in Roxburgh's *Hortus Bengalensis* (1814), p. 65. When we say name only we mean without description, although Roxburgh indicated that it was a large tree, and gave the season

of flowering and fruiting. Recently Dr. Brandis (*Forest Flora*, p. 418 in a footnote) has stated that Blume must stand as authority for Ficus elastica, "because Roxburgh did not include it in his *Hortus Bangalensis*, and his *Flora* did not appear till 1832, whereas Blume published it in his *Bijdragen tot de Flora van Nederlandsch Indie* (1825), p. 446." But this objection fails inasmuch as the name is included in the *Hortus Bengalensis* in the place quoted. Blume received the plant from the Calcutta garden, and published the name as his own. We sometimes find Linnæus cited as the authority for the name, but, as we have shown, it could not have been known to him.

In 1815 five years after its discovery, as we learn from Sweet's *Horus Britannicus*, 2d ed., p. 461 it was in cultivation in this country. Its hardy nature enabling it to bear smoke, dust, gas, wet and drought better than most other plants, it soon became a common and favourite ornament in sitting-rooms, and other parts of dwelling-houses, as well in this country as on the Continent. Although it will bear a great deal of rough treatment it repays a little care by producing leaves as much as two feet in length; but for indoor (dwelling-house) decoration it should be kept in small pots, in moderately rich soil, or it will soon outgrow its space. Indeed, it is remarkable how long this tree, which attains gigantic dimensions in a wild state, may be kept healthy and ornamental in a mere handful of earth. With regard to the size of this tree in its native country, we find some interesting particulars in William Griffith's "Report on the Caoutchouc Tree of Assam," in the *Journal of the Asiatic Society of Bengal*, vii., part I, p. 132. In the district where it grows it overtops the other vegetation, not only growing tall, but forming colossal trunks. The dimensions of one tree measured by Griffith were:—Circumference of main trunk, 74 feet; ditto of main trunk and supports, 120 feet; estimated height, 100 feet. The nature of the trunk is very extraordinary, and is thus described by Griffith:—"It differs in the first place from the ordinary trunk by its sculptural appearence, and it is from this that its extremely picturesque appearance arises. The appearance arises entirely from the tendency of these trees to throw out roots. both from the main trunk as well as from the branches, and from the extreme tendency these have to cohere with the trunk or with each other. If the roots are thrown out from or very near the main trunk, they ordinarily run down its surface, and cohere with it firmly, and hence the sculptured appearance. If, as happens in some, they are thrown from the branches at such a distance from the trunk that they do not come in contact with it, they pass down to the earth and form what I call supports. These supports never appear to produce leaf-bearing branches, so long, at least, as they remain attached to the tree. They are generally perfectly straight at first, becoming conical only by divisions at the apex when near the earth, and by the mutual adhesion of these divisions. Very generally it would appear this species, as well as some others, vegetates in other trees; its first processes of growth being probably similar to those of other dicotyledonous trees. The roots, however, in obeying the laws regulating their descent, soon come into contact, and wherever they do so a mutual and firm adhesion is the result. A network is soon formed round the tree; the size of its reticulations soon diminishes with the increase in the number of roots; and at last a nearly solid and excessively firm cylinder is formed, which encloses, as it were, in a case, the tree which originally protected the young seedling. To such an extent is this carried that the death of the tree is sure to occur sooner or later. In such a case as this the fig tree has, it may be said, no trunk at all comparable to ordinary trunks, which result from growths in an ascending direction. In these they originate from the aggregation and cohesion of roots, or from growth in a descending direction." From Griffith's observation it appears that this tree rarely fruits in a wild state, and still more rarely does it fruit under cultivation in this country. An instance occurred in the garden of Mr. Boyce, of Clapham, in 1874, and the fruit was figured in this journal, n.s., ii., p. 359.

THE AMERICAN INDIA-RUBBER TREES AT NILAMBUR.

Letter from R. Cross, Esq., to the Conservator of Forests, Madras, dated Ootacamund, the 6th March 1881.

(From the *Indian Forester*, October 1881.)

Respecting my previously-arranged journey to visit the sites proposed for the cultivation of the various species of American India-rubber trees, I beg to state that I proceeded on this duty on February 15th, and arrived at the bungalow at Nilambur on the evening of the 17th. The course pursued was by Naduvatam, Gudalur. and Nadgame, descending afterwards by the Carcoor Ghat to the plain land below.

On the following day, accompanied by Mr. Ferguson and Mr. Hadfield, his successor, I visited the site of the newly-introduced rubber plants. These have been planted in an open space of teak forest land on the bank of the Nilambur river.

The first sort examined was that which furnishes the rubber known in the market as "Ceara scrap." The tree belongs to the Mandioca family, and the roots are furnished usually with tubers, which vary in size and number in accordance with its growth. The plants of this sort have, in the brief space of two years, shot up in the most surprising manner, the highest upwards of 30 feet in height, and are now yielding an abundant crop of seeds. I was shown one strong rank sapling, which, in five months from the time of planting, had grown up and produced flower.

This region is. without doubt, admirably adapted for the growth of the tree; and the robust and vigorous appearance of those already planted is certainly quite equal to any trees of the same apparent age and size I saw when engaged in collecting the original plants near Ceara on the coast of Brazil. At the same time I would confine the general planting of the Ceara rubber to rather dry, arid situations and poor soils, reserving the good, deep, moist sandy loam of the Nilambur river and its tributaries for the *Castilloa.*

Mr. Ferguson was desirous of proof of the actual existence of rubber in his Ceara saplings; and, although these were too young to yield this product, I resolved to make an attempt to satisfy him. The natives at Ceara, in bleeding this sort, simply slice off the outer portion of the bark on one side of the tree from the base to a height of four or five feet. The milk exudes from the pared portions of the trunk and runs down in little courses. By the following morning the milky juice of these courses is sufficiently solidified to be pulled from the tree in strings, which are rolled up into balls as the work of collection proceeds.

When this process was tried on one tree the milk exuded freely, but next day on examination it was found that the greater portion had evaporated, showing the watery and immature state in which the milk exists in young growing plants. However, on making incisions on the collar and largest roots of the plants milk of good quality was obtained, which next day was found coagulated. From the collar of five saplings about an ounce of rubber was obtained, which in appearance, elasticity and odour, could not have been distinguished from "Ceara scrap" as seen in commerce. But it is manifest the trees ought to be allowed to attain some size before being wrought.

The propagation of this sort is as easy as a willow. I made a few cuttings just to show the proper method, and these were planted near the bungalow. But now that the trees are producing seeds. recourse to cuttings may not often be necessary. Each seed before sowing should have a small portion of the outer shell broken off by a pair of pincers, simply to allow the moisture to reach the embryo, which in the operation should not be injured or by merely burying the seeds in moist sand germination will take place much earlier.

The Para Rubber.—This rubber tree, which yields a valuable commercial product, has seemingly not found its proper habitat at Nilambur. The young

plants have shot up like long whip-handles with a bunch of leaves on the top. There is not, however the slightest reason to despair of success. Some plants, say a dozen, should be planted in the Carcoor Ghat at an elevation of 1,000 feet, and another dozen might be put down at 2,000 feet or, for example, somewhere in the vicinity of "Campbell's Rock." A little clear site at each place, a few yards in extent and easily reached from the road would suffice for these experiments. The Para tree is easily multiplied, and recourse may be had to the same way as that adopted for willows. I made some cuttings, which were planted in a moist situation on the river bank. From these it may be seen whether additional humidity improves the character of the plant.

Central American Rubber.—The *Castilloa elastica*, yielding this description of rubber, and of which there are only three plants, has evidently found a home on the bank of the Nilambur river. It may be considered premature to judge or form an opinion from the appearance of only three plants, from three to four feet in height, and indeed this is so. But besides having looked carefully and attentively at the physical appearance and development of these plants, I have considered and remembered the characteristics of the extensive region inhabited by this tree. The *Castilloa* is found growing throughout the Central American Republics always at low elevations, and certainly I do not think I noticed it anywhere above an elevation of 2,000 feet. North of the Equator, it is met with in the wooded districts, which bound Jembico in Mexico, extending southward through the dense exuberant forest regions of the Central American Repubics and stretching across from the Atlantic to the Pacific on as far as the river Atrato, after which it is confined to the forests and base of the mountain ravines bordering on the Pacific coast, and thus continues to Santa Rosa and Arenillas near Tumbex districts, which lie adjacent to the Peruvian desert. Throughout this vast expanse of country there is, without doubt, considerable variation of climate. But it so happens that the periods representing the wet and dry seasons coincide in a remarkable manner, at least as far as I can learn, with the occurrence of the same periods in the Western Ghats. In the region of the *Castilloa*, especially on the Pacific side, the dry season sets in about the beginning of January and continues until April. During this time the rank swamp growth is occasionally so dry that it is set on fire and burned. In the dry season the tree becomes deciduous, and in March pushes forth a fig-shaped fruit, which ripens with a beautiful scarlet crown, all the rest remaining green. In August the fruit is ripe during the heavy rains. The seeds cannot be dried, and must be planted as soon as the fruit falls. It is not found growing on swamps or inundated land, but on the flat moist banks of rivers and steep sides of ravines, where the roots may be seen running down the banks, for a distance of 15 or 20 feet to the very margin of the streams.

The *Castilloa* is the largest known rubber-producing tree, its massive trunk sometimes rising in close humid spots to a height of 80 feet clear of branches, and is only exceeded by the "Quipo," a gigantic species of *Bombax*. Sometimes the trunk divides into two stems, evidently from the leading bud having been broken when young, and those trees are less prized by the rubber collectors. In order to extract the milk, the usual course is to cut the tree down and make notches round the trunk at about a foot apart. Broad leaves or calabashes are then placed underneath these into which the milk drops. In a few localities, especially at Nicaragua, the trees are not felled. The practice is to make a perpendicular channel in the bark from the base of the trunk upwards, and then make a number of cuts on each side leading into the main channel. A good deal of milk always adheres and solidifies in the primary and side channels, which is afterwards collected. These "dregs" are much valued in the markets of the United States. I have heard it argued among the natives that it was probably more profitable to cut the tree down than trust to the bleeding channel process. My own opinion is, that the channel method is good, specially for the

Castilloa, but the collectors gash the trees so badly in working that the after-flow of milk is much lessened. Besides, at the base of the main channel, they drive an iron spout into the trunk in order to convey the milk from the tree to the calabash. A piece of bamboo, luted by means of clay to the base of the channel, would serve the same purpose just as well, whilst the wood of the tree would escape permanent injury. In combination with the channel process, collecting by the cup method will often be found useful, especially in the case of large trees, as cups can be applied to various parts of the tree, which, if operated on by channels, would result in the loss of much milk. I have described the cup process in my Report to the India Office on the collecting of Para rubber plants with date of 1877. Respecting the quantity of rubber which may be obtained from a tree, the amount would depend on the age and size of the tree, season, habitat, and likewise mode of collecting.

During the rainy season the flow of milk is greater, and this also is the case with the trees growing in humid localities. The skill and care of the collector must also be taken into account; some spill and waste a great deal of milk.

A *Castilloa* tree, if carefully and judiciously tapped with a diameter of 1½ to 2 feet, may be expected to yield about 12 pounds of rubber per annum.

Of all the different species of rubber-producing trees, the *Castilloa* should prove under cultivation the most remunerative. The banks of the Nilambur river and its tributaries afford, in my opinion, suitable sites for planting; and I have no hesitation in stating that the lower portions of the Carcoor Ghat would grow and sustain as fine *Castilloa* trees as any district of Central or South America. The conditions on the bottom and deep side ravines of the Carcoor Ghat are of the most superb description. But no doubt many excellent sites exist along the course of the Western Ghats southwards towards Sispara, and likewise to the northward in the Nagar region. In planting the land should be cleared so that the trees may grow up robust, but there will be little mamatie work; for, once the *Castilloa* gets up it will overtop the majority of the Ghat trees.

The propagation of this sort from a limited stock will require more skill than would be necessary for multiplying the Ceará or Para rubbers.

As yet that plant at Nilambur presents few materials for propagation, though, as the growth of the tree is rapid, a supply of cutting shoots will probably be available after the burst of the monsoon. By erecting a small platform, we were able to lay a branch with seven shoots, so that when these are rooted the stock will be at once fully doubled. I would certainly advocate the multiplication by cuttings of the *Castilloa* as it is not an early seeder. In America the trees do not usually bear seed until they are about eight years old. Before the lapse of such a period, thousands of *Castilloa* plants might be growing up into young trees at Nilambur, derived by means of propagation. I regret to state that time did not permit me to visit the Silent Valley as a special site for the *Castilloa*. I have no doubt, however, that it will be found well suited for the growth of the tree.

I returned to this place on the 25th of February.

In conclusion, I trust the way in which this duty has been performed will meet with approval.

(*Copy of a despatch from the Secretary of State for India to the Government of Madras, No.* 21 *dated the* 21*st July* 1881.)

I learn with satisfaction from the copies of the Proceedings of Government which accompanied Your Excellency's letter No. 6 of the 19th May last, that Mr. Robert Cross, who was deputed to visit the Cinchona Plantations on the Nilgiri hills and the American Rubber Plants at Nilambur, has been able to report favourably upon them. Well acquainted as he is with the habitat of both these plants in Southern and Central America, and their introduction into India being greatly due to his enterprise and ability, I attach importance to his opinion that Southern India is a perfect field for the cultivation of the

various commercial products of tropical America, and that the banks of the Nilambur river and other sites along the course of the Western Ghats as fitted as any district in Central or Southern America for the growth of the *Castilloa* trees, which, of all the different species of rubber-producing trees, should, he considers, prove the most remunerative.

2. I agree with your Excellency that Mr. Cross's reports are valuable additions to the information already recorded on the subjects with which they deal, and I approve of your action in retaining his services in India until such time as the *Calisaya de Santa Fe* plants may be considered sufficiently established and safe from all ordinary risks.

THE *PARA* INDIA-RUBBER TREE (*HEVEA BRAZILIENSIS*).

(From the *Indian Agriculturist*, March 1, 1877.)

Inquiries have for some time past been set on foot, with a view to obtaining complete information regarding the production of indiarubber, and the great intrinsic superiority of the rubber from *Para* in Brazil (*Hevea Braziliensis*) over all other kinds has now been placed beyond doubt. The experimental cultivation of the *Para* tree has been tried in Bengal, but it has failed. It is feared that the plant will not find a congenial home in Bengal or in Assam, or in any part of Northern India. The *Para* tree is essentially a tropical plant requiring an equable moist climate without any distinct season of cold or hot weather. Endeavours have, however, been made with more success to acclimatise the *Hevea* in Tavoy, Mergui, in the Nicobars, and at the Botanical Gardens in Ceylon. The following note on the cultivation of the tree has been recorded by Mr. H. A. Wickham, and has been received in India through the office of the Secretary of State:—

"The introduction into India of the true *Para* India-rubber (*Hevea*) may be said to be now fairly inaugurated. If it is not a great success I think, without doubt, the fault will be that it has not been planted out in suitable localities. The India-rubber tree (*Hevea*) grows naturally throughout the Amazon valley, with the exception of certain localities. I found it very abundant high up, on the Orinoco above the junction of the Guaviare (the letter stream by right indeed should be styled the Orinoco). It is plentiful on the banks of the Cassiquiare, the curious bi-furcation of the Orinoco by which it contributes water to the Rio Negro, and converts Guagana into an immense island. I do not know how far it may extend up the Maranon into Peru, never having been there. It is abundant and very fine about the cataracts of the Tapajos, and it was on this river that I obtained the seeds which produced the plants now to be despatched from Kew to India."

"I also found it growing in the interior between the Tapajos and Xingu. The rivers from which the largest supply is now brought by the traders are the Purus and the Madeira. In its native forests, it grows dispersed among the other forest trees, two or three trees rarely being found in juxtaposition. In appearance the *Hevea* are handsome trees, with straight cylindrical trunks. They differ wholly from the Ule trees—the Central American India-rubber trees (*Castilloa*), which I had seen in Moskito and Nicaragua. The wood is soft and perishable. As in the great majority of tropical American trees, the bark is not very thick. It is of a grey colour on the surface, but when scraped (as has frequently to be done before it is possible to tap them in some of the moister districts owing to the thick growth of the moss, ferns and orchids on the bark) approaches in appearance and colour the coat of a light bay horse. Under the native mode of tapping, however, they soon present a warty, disfigured appearance. The seeds grow three together in a sort of hard pod; this pod bursts when it is ripe and becomes heated by the sun, with a sharp popping sound, and scatters the seed for a considerable distance around the trees. I have been assured by an Englishman, long resident in the country as a trader, that an

oil closely resembling linseed oil in its properties, can be extracted from the seed."

"It is worthy of notice that the tree casts its seed at the same time of the year both on the Orinoco and Amazon, although the wet and dry seasons are reversed in the two valleys. It would be interesting to note whether the seed continues to fall at the same time of year in its new home in India. The rainfall varies considerably in different districts where the *Heveas* are found. In some districts, the year is nicely divided into wet and dry seasons, each of about six months' duration, in others it rains more or less all the year round. In such districts it is more difficult to collect the *caoutchouc* profitably. If the stem of the tree be wet when it is tapped, the milk spreads over the surface of the bark and is lost. Again, if a shower should come on before the milk is collected from the cups, and it become mixed with water, it will not congeal and so is also lost. The range of temperature in the India-rubber country is from about 73 deg. to 88 deg. throughout the year, on the Lower Rio Nigro it increases in the afternoon to 100 deg."

"From what has been said, it may be seen that the main part of the rubber must be collected during the dry season, although the "Ciringeros," who live near their "Ciringals," or India-rubber walks, improve their opportunity by tapping their trees whenever fine days occur during the rainy season. The "Ciringero" occasionally give his trees a rest, but the trees are always tapped excessively. It is astonishing to what a degree they will stand tapping. I have seen large trees apparently none the worse, further than that they were somewhat disfigured by the gnarled appearance of their bark, the owner of which assured me he had tapped for twenty years successively, but then he tapped them himself, and had an interest in their preservation. These same trees scattered their fruit in abundance. An industry more in accordance with the character of the South American, it was difficult to find, the labour so small and so remunerative. I have myself collected 10 lb. of rubber per day, tapping 70 or 80 trees of various size. An experienced Tapuyo Indian can collect much more. If such be the case in woods, where the trees are scattered and much time is necessarily lost in getting from one tree to another, what will be the profit of a well arranged plantation of these trees under good supervision? In the "igapo," or low lands of the rivers, flooded during the rise of the waters, there is a spurious kind of *Hevea*. It is called by the Natives "*Ciringa do igapo*" or "Barigordo," from its habit of growing with a bulged stem. The seeds of this species are much longer and larger than those of the true rubber. The milk appears to be worthless.

"When the native has discovered for himself a district in which "Ciringa" trees are sufficiently numerous and near together, he first connects them together by cutting a "picado," or path, with his bushknife. Having thus discovered their relative bearing he next straightens and clears out his path, endeavouring at the same time to take in as many trees as possible in each path, and to make all the paths converge to a certain spot where he has put up his "*rancho*" or "*barraca*." This done, and having collected a supply of the old nuts of the Inaja (*Maximiliano Regia*) or other palm trees, or of the outer shell of the Brazil nut, he is ready to commence operations on the first fine day. There is some diversity in the manner of taking the rubber milk on the Amazon. In some districts long strips are procured from the inner pith of the foot stalk of the leaf of the Inaja or the Bacaba palm. These are attached obliquely round the stem of the trees, with sharpened pieces made out of the hard covering of the same leaf stalks. This being smeared on the inside with wet clay serves to form a channel to collect and conduct the milk into the cup placed to receive it. In the other way, which I consider the better, three or four cuts about an inch long, are made in the back with a minute axe. The cups are put in a ring round the trunk, usually a span or more apart. In this way the number of cups is proportioned to the size of the tree."

"Tin cups are used. They are made slightly concave on one side in order to fit the convexity of the tree trunk. These are fastened to the tree with a

piece of kneaded clay, of which the "Ciringero" carries a supply in his bag. The tapping always takes place as soon as there is light enough in the forest to see by. One man is apportioned to each path, say, containing 100 trees. When he has tapped and cupped his trees, he sits down at the end of the walk for half an hour or so. As soon as he perceives that the tree last tapped has ceased to drip the milk, he starts at a trot on the back track, detaching and emptying the cups into his *calabash* as quickly as possible. The cups he leaves up-side-down at the base of the trees. Speed throughout is a great object, as the milk speedily coagulates; than it can only be sold for an inferior price as "*sernambi*." When the men arrive at the central hut from their different paths, they empty their milk into one of the large native earthen-ware pans. Care is taken to squeeze out with the hands all the already coagulated curd-like masses. These are thrown to one side to be made up into balls of "*sernambi*." Earthen pots resembling miniature kilns are placed over small fires, and the "Ciringero" sits down to the really tedious part of the business. He drops a handful or so of the palm nuts down the narrow neck of his little kiln, and forthwith arises a dense smoke. He now takes his wooden mould, not unlike a *fives* bat in form, and holding it over the pan pours some of the milk over it, keeping it turned, so that it shall not run off before he succeeds in drying it in an even surface, as it soon does, while being passed backward and forward through the smoke. This is continued, one coating of milk after another, until he has finished the supply of milk for the day: he then sticks his mould up in the thatch for the repetition of the process next day, and until he is satisfied with the thickness of the "*burcuit*," I believe very good rubber might be made by simply allowing the milk to congeal in moulds during the night of the day on which it has been tapped, if, on the following morning, it were placed under a very powerful press in order to expel the fluid contained in the cheese-like cells. When fresh, the milk has a very agreeable smell and taste, but it soon becomes putrid. The child of an Indian woman employed on my "*ciringal*" used to drink considerable quantities of the fresh milk. I suppose it was rendered harmless by becoming mixed with saliva, as it will not congeal if mixed with water. There are many trees in tropical America which produce milk from the bark yet more copiously than the *Hevea*. Who knows but that some day equally economic use may be made from some of them? With regard to the success of the introduction of the *Hevea* into India, much will, of course, depend on the nature of the soil on which they are planted. In Venezuela and Brazil I found the *Hevea* growing on two classes of country, the high clayey uplands embraced by the branching rivers, but still at considerable distances from them, and on the low alluvial lands immediately bordering on them."

From the far greater size and apparent age of the trees, I cannot but imagine that the original locality of the tree was in these uplands. The fact of their being so generally found on low lands bordering on the waters may be accounted for. The seeds are scattered widely when they burst; many of them fall into ravines and gullies, and are carried by the water-courses of the rainy season into the rivers, to be cast up by tide and windy squalls, and readily take root on the rich soil of the alluvial islands and shores of the back waters. In illustration of this, I have frequently seen a string of *Hevea* growing even on a beach backed by sandy lands, far from their proper localities. Although I know nothing personally about the climate of the East Indies, yet I imagine, from what I have read, that the Malay Peninsula is most likely to combine the climatic conditions required by the India-rubber tree of the great Valley of South America."

"It is a mistake, naturally fallen into it by the travellers who have passed up and down the great waterways of South America, without having penetrated far into the interior high clay lands enclosed by them, to suppose the *Hevea* are confined to the low, often-flooded islands and margins of rivers. Growing on these clayey uplands, I met with the largest of these trees, rivalling in height and girth all but the very largest trees which grow in these parts. At

the same time, perhaps, on rich alluvial lands, would be found the best localities for establishing plantations of these trees. Nor do I think it would prove a serious drawback, if they should be planted on lands which become annually flooded to the depth of a foot or so for a few weeks in the year. The land selected should, I think, be heavily timbered. The timber to be cut down some eight or nine weeks before the first rains are expected, in order to give time to get a good burn over the ground. The ground also should be cleaned up sufficiently by piling and burning the logs; those remaining to be rolled on one side. The plants might be set out in walks, converging to a central point in order to facilitate the collecting of the milk. I would strongly advise that the *Hevea* should be planted alternately with *Cacao*; these low bushy trees, would shade and keep the ground moist, without interfering in the least with the *Hevea*, which would soon tower above them. This plan would also much increase the value of these plantations."

"Another thing I would recommend. The milk of these trees is yielded in much greater abundance near the ground, and when by some chance, an elbow of root is protruded above the ground, the flow of milk from it, on its being tapped is very much greater than from any other part of the tree. Now would it not be possible to devise some method by which the roots might be induced to put up elbows above the surface of the ground? Great caution must be used in tapping the trees not to penetrate beyond the bark into the wood. Great numbers of trees are destroyed in this manner on the Amazon. As soon as the wood is injured, certain species of boring beetles attack the tree, and it soon dies. From what I have seen of these trees in their native country, where I have occasionally known them planted, and have made some experiments on their growth myself, I have ventured on the foregoing remarks, feeling at the same time satisfied that this will be found to be quite the best manner of forming a plantation on a large scale. If this plan were followed in a suitable locality on rich alluvial soil, the tapping of the young trees might commence gradually in from seven to ten years after planting out, and would soon become the source of great revenue."

AMERICAN RUBBER MANUFACTURES.

(From the *Boston Journal.*)

The manufacture of india-rubber gum into various articles of use and necessity is one of the most curious and interesting in the whole range of our varied industries. The uses to which it is adapted are so many and so various that it would take almost a volume to describe them. There is hardly a machine of any kind in use today into whose construction or working rubber, in some shape or form, does not enter. It is used for springs, for tubing, belting, for waterproof clothing for man and beast; for bedding, blanketing, waterproof covering, bandages for wounds, etc.; articles connected with the stationery trade, mattings, carpets, fancy articles of many kinds, combs, jewellery, and, in fact, almost everything that can be thought of where it might be used, and thousands of other things that are not dreamt of by the general reader. "I think," said an india-rubber manufacturer, "that there are from three thousand to five thousand articles of use, ornament, etc., that are composed either wholly of rubber, or having the gum for their base. We have in our store, I think, nearly two thousund." Thirty to forty years ago the rubber trade was a mere nothing. The discovery of the principle of vulcanization, however, opened up a vast field for the application of the gum products, with the most wonderful results. "It is a law of trade," says *Bradstreet's*, in an article on the manufacturers of rubber, "that one article of product will never supersede another unless it has some special excellence that makes it more desirable, and that rubber products are superior for belting, packing, and the thousand and one other purposes to which they have been and are being applied to products

made of materials that had been in use for ages, is a proof that such products are really superior."

Be this as it may, it is quite certain that, in the various and varied manufactures of rubber, there is a progress surprizing even to those who have been many years in the business. Some of the best talent is all the time engaged in improving old processes or inventing new ones, or in finding new uses for this wonderful gum. Progress is, therefore, manifest everywhere. Neater and better articles are every day produced. In some respects, if not all, the new products are decidedly preferable to the older ones, though the latter may still have, and will continue to have, their uses for some time to come. For purposes of protection from rain, the gossamer coat, which weighs from ten ounces to a pound and a-half, is fully as good as the old-fashioned garment, weighing four or five pounds. To give an idea of the importance of the rubber industry of New England, of which Boston is the centre, it may be stated that, in the manufacture of goods for mechanical uses alone, the amount of the business reached 4,000,000 dols. last year, the single article of machine belting yielding from one-half to five-eighths of that amount. The total production of rubber manufactures in the United States during the year 1880, it is estimated, will reach nearly 20,000,000 dols. in amount. Of this amount New England will produce about two thirds, or from 13,000,000 dols. to 14,000,000 dols. worth, nearly one-half of which is represented by the articles of boots and shoes alone. The amount of gum required to carry on this enormous business is very great, being about 36,000 000 pounds per annum, one third of which is known as Pará gum, which is of a uniformly better quality than any other kind used. The other two-thirds are composed of coarse gums, and the present season, among other causes of complaint, the rubber manufacturers find that there is an unusual amount of refuse matter, such as leaves, clay, etc., in the inferior crude gums. From this circumstance it is held that Pará rubber is the cheapest to use, because it is the purest. The shrinkage in this gum in washing is from 10 to 20 per cent., while in the other gums it is from 25 to 35 per cent. The hard times of the past few years had a depressing influence on the consumption of rubber products, and, as a consequence, about a year ago the raw materials had accumulated on the market in such quantity as to cause a large supply than was needed by the trade. This, together with prevailing tendency to lower prices, had the effect of bringing the price about a year ago down to 45 cents a pound on an average, and it had been down to even 30 cents. Early in the last season, owing to combination of circumstances, it began to advance until, at the present time, it is in the neighbourhood of 80 cents, and promises to go higher. It is said that the gum now on the way to this country cannot be delivered short of 1·01 dols. or 1·02 dols. a pound. Among the causes of the advance in prices may be named one that had a curious origin. It appears that the area of South America in which the gum is obtained is a very large one, but that another of its products is the ivory nut, or vegetable ivory. In the early part of the present year, and throughout the winter, the demand in this country for the ivory nut was very great, which so stimulated the industry of gathering it that our market was soon overstocked, and prices declined very rapidly. But this demand for the ivory, while it lasted, by taking labour away from the gathering of the rubber gum, had the effect of lessening the rubber supply. Then the war between the South American States, in which ports have been closed to traffic by blockade, and frontiers guarded from intrusion, stopped, in a degree, the transportation of the gum from the interior—where it is gathered—to the sea. But the rubber gum is now being received in greater supply. These causes were operating to lessen the supply of rubber to the manufacturers in the States and Great Britain, when another important element entered into the prevailing condition of affairs, causing an active demand for all the products of rubber. The recovering industry of our country became rapidly very active, and everything boomed along as it has been booming ever

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since. Every mill and factory that was started up needed rubber belting, rubber packing, rubber hose, etc., and it couldn't start without them. In fact, all kinds of industry needed rubber in some shape or other, and, before starting up, had to have their supplies of these articles. In some cases they could be at once accommodated, but the stocks were soon exhausted, and special orders poured in upon the rubber manufacturers in such abundance that they did not know which way to turn. Indeed, from the first of April last there has been no let up in certain lines of rubber manufacture, notably that for mechanical purposes. Most of the factories would have been run night and day, if they had the necessary skilled labour to do it; but they had not, and hence there are many of them that have not, even up to the present time, caught up with their orders. Taken as a whole, the rubber trade may be said to be in good condition, though manufacturers complain that, while raw materials of all kind have advanced about 75 per cent., on the average, their products have advanced in price only from 30 to 50 per cent. In other words, they say that they are selling their goods today, on the average, 20 per cent. below what they should receive for them, and do not see, if rubber gum is going to advance on present prices, how they are going to avoid an advance in their products to the trade.

The manufacture of rubber boots and shoes is a very important industry. There are eleven factories in the United States engaged in the production of these goods, eight of which are in New England. These manufacturers were generally caught in the early part of the season by accepting orders for future delivery; but they have got bravely over this pull-back, and have been filling largely increased orders for several months past. They say their productions will amount the present season to an advance of at least 50 per cent. over those of last year. In the branch of rubber manufacture comprising rubber clothing cloths, hospital sheeting. air work, horse covers, carpetings, mats, toys, and numerous other things that need not be here named, the increase over the business done last year is also very large. Manufacturers of these goods have been very busy and are doing, on the whole, a very satisfactory business. They report a very large demand for wringer rolls, carriage and melodeon bellows cloths, and cloths to be made into clothing of various descriptions. One of our largest manufacturing companies in these lines of goods, with headquarters in Boston, turns out from 1,200 to 1,500 wringer-rolls per day the year round. It also manufactures rubber cloths in quantities of from 50,000 to 100,000 yards at a time. These cloths will average about 75 cents a yard wholesale. This company manufactures clothing of various kinds, at the rate of from 500 to 600 garments a day, including horse clothing. This number also includes about 200 light or gossamer garments a day. The manufactures of the finer articles of rubber embrace druggists' sundries, surgical instruments, and stationers' goods. The number of articles that come under each of these headings is legion. A few may be named, such as bandages for wounds and varicose limbs, sponge bags, dress shields, nipples, atomizers, syringes, etc., and erasers, rubber bands, pen-holders, etc. There are ten or twelve concerns in the United States that manufacture these goods, the largest, and the one whose productions are everywhere regarded as standard with the trade being located in Boston. There has been a very large advance in the manufacture of these kinds of rubber goods, and only a moderate advance in prices.

There is a branch of rubber manufacture which has grown into such importance within a few years as to call for more than a passing notice, and that is the industry of rubber gossamer clothing. This light grade of garments was introduced into our market some seven or eight years ago, and, though the prices charged for it were apparently extravagant, its desirableness overcame this to a degree, and it became a favourite with those who could afford to wear it. Our local manufacture of these garments had a very weak and unpromising beginning. The reason was in part because the business was in some respects an experimental one. The work of manufacture was done largely by hand, and a good deal of difficulty was encountered in every stage of improvement of the

business, especially in combining the gum with the cloth, and doing the work by machinery. Processes had to be worked out to a satisfactory result, and machinery to do the work quickly and cheaply had to be invented. The machines have been perfected, a coating of odourless gum has been successfully applied to cloths of various kinds, and it may be said that the chief obstacles to the large development of the business have been overcome. One of the companies engaged in this manufacture, whose warerooms are in Boston, has done more business in the past year than it had done in the two and a half previous years of its existence. Its business for the past year amounted to about 400,000 dols., which is about one-half the total business done by all the companies in this line of manufacture.

When this company commenced operations about three and a-half years ago, it had only eight hands in its employ, and a plant that cost 3,000 dols. Now it has 241 persons on its pay-roll, and a plant worth 50,000 dols. At first it worked only a few sewing machines by foot-power; now it has two large floors filled with machines run by steam-power. Covering cloth in the way desired required new machinery, which had to be invented. By its aid, and some other processes of manufacture, prices of garments have been reduced to about one half what they were a few years ago. The wholesale price of ladies' cloaks, which formerly sold for 8 dols. and 10 dols. each, has fallen as low as 1·75 dols. The company is now making an average of 600 garments a day, and aim to enlarge its capacity to 1,000 a day. It has not been able to get abreast of its order since the 1st of last April. When the company in question started, the other manufacturers supposed that no American fabric would do for their work, and that only Scotch lawns were fit for the purpose. The managers of this company, however, thought differently. They went to one of our cotton manufacturing firms and obtained a finer and a better article than is made in Scotland, at a less cost of some 20 per cent. Some of their lawns are as fine as 140 threads to the inch. This company turns out about 5,000 yards of its cloth a day. There are things connected with the manufacture of these gossamer cloths that would be interesting if space would allow of their consideration at this time. None of the companies making them have patent processes; their methods are their own secrets, jealousy guarded. They have succeeded in completely deodorizing the rubber used, and, by some combination with it, have with the further aid of sunlight upon its surface, rendered it smooth and not liable to stick, as is the case with English gossamer cloths. The sunlight oxidises the surface in a way to render it smooth and inadhesive, but it is most intimately combined with the silk or lawn on which it is spread, and is thoroughly water-proof. Garments are made to weigh from ten to twenty ounces, and are rolled up into parcels twelve inches long by two in diameter, to go into the pocket or satchel, the finer or lighter being the more costly, as they are made on silk or finest lawn. In the early efforts at the manufacture of gossamer cloths, great difficulty was found in making the rubber adhere permanently to the silk, owing to the presence of oil in it; but this difficulty has been overcome, and a most perfect union secured. Gossamer clothing is now in high and growing favour, and will no doubt be the waterproof clothing of the future.

In regard to the demand for rubber goods for wear, etc., it may be said that, though the fall season so far has been generally remarkably fine, there has been a large demand from the trade, and manufacturers in some branches of clothing, etc., find it difficult to meet the orders which are being pressed upon them. There is a phase of the rubber trade that may be mentioned in this connection. Formerly the large manufacturers established agencies in various sections of the country for the sale of their goods. This system has become practically obsolete. Young men who learned the business in the East have spread out in various directions, established stores for the sale of rubber goods, and now lay in stocks on their own account, and do business in exactly the way as merchants in other lines of goods. The market for rubber products of

American make is not confined alone to the United States. Our manufacturers supply dealers in all the countries of Europe, as well as India, China, Japan, Australia and South America. The demand from abroad for some descriptions of American rubber products is constantly increasing.

THE RUBBER INDUSTRY IN CEYLON.

(From the Report of the Director of the Royal Botanic Gardens, Ceylon, for the year 1881.)

Much activity is being shown in the search for new rubber-yielding plants. As I have before observed, caoutchouc seems to be more or less produced by nearly all apocynaceous plants, and a large number of artocarpaceous and euphorbiaceous ones also, but it is not in a state available for ready extraction or for commercial purposes in any very large number of them. Thus in our native species of *Willughbeia* (*W. zeylanica*) which I have had the opportunity—through the kindness of Mr. J. C. Roberts of Udugama—of experimenting with, and which gives plenty of milk, the caoutchouc, which is abundant, after first passing through a viscous sticky condition dries into a putty-like substance of no great tenacity and scarcely any elasticity, and this whether treated by heat, with alum, with alcohol, or simply allowed to dry. The plant is a climber, and the stems, which are said to attain over six inches in diameter, extend to an immense length. This result is disappointing, as a congener at Singapore (*W. Burbidgei* of the Kew report for 1880, formerly referred to *W. martabanica*) affords a very fair rubber known as "Gutta Singgarip." Of this sort we have received a case of 50 plants (which was kindly brought from Singapore by Mr. F. A. Fairlie), and we previously had a few plants from Mr. Murton. This and other less-known species of *Willughbeia* also apparently afford some of the rubber of Borneo, called "Gutta Susu" in the market.

But the most promising of the new rubber plants are the species of *Landolphia*. The African kinds of caoutchouc are mainly, and on the East coast wholly, supplied by these; and, by the exertion of Sir J. Kirk chiefly, several have been now brought into cultivation. To him directly I am indebted for a consignment of seeds (in the fruit) of the narrow-leaved species called "Matere" or "M'tiri,': which affords the best rubber of the Zanzibar coast, and which it is proposed to call *L. Kirkii*. Of this we previously possessed but a single plant at Heneratgoda, now over two years old, and widely climbing over a wild nutmeg tree. Young plants of this have also been received from the Royal Gardens, Kew, during the year, as well as of three other species, for an account of which reference must be made to the Report of that establishment for 1880, pp. 38-43. Of two of these, *L. Petersiana* (*Willughbeia* Klotzch), and "No. 4," (l. c. p. 43), the broad-leaved species, we have some 18 plants at Peradeniya, and of the other, *L. florida* ("Mbungu" of Zanzibar), a single fine specimen. These and several other allied and undetermined kinds (including two plants of a Madagascar rubber from the Ceylon Company, Limited, and the West African "Apocynaceous" rubber of Mr. T. Christy's "New Commercial Plants," No. IV., p. 13) have been planted out, some at the foot of old trees, others against large dead trunks and branches fixed in the ground.

The wonderfully rapid development of trade in these African rubbers is, in spite of their habit of growth, leading to their destruction. From two districts of Eastern Africa alone the export of rubber in 1880 exceeded 1000 tons, the price having risen in one year from £140 to £250 per ton.

Sir J. Kirk thinks the Landolphias (especially *L. Kirkii*) by far the most promising of rubber plants for cultivation in plantations; their stems can be cut down at frequent intervals for the rubber, and fresh shoots readily spring up from the stools. He quotes with approval, in reference to the extraction of the caoutchouc, the suggestion of Mr. T. Christy (Commercial Plants No. I., p. 9), that the stems after cutting "could be taken to the rolling mill, and the crushed mass digested with bisulphide of carbon in which the rubber

is soluble, but which does not dissolve the gum and resinous matters contained in the plant, and which if left in the rubber would injure its quality."

Of other African kinds, Mr. T. Christy has sent a few seeds of a plant determined at Kew to be *Tabernæmontana crassa*, and a specimen of *Ficus populifolia*; whilst we have *F. Vogelii* also from Kew.

With regard to the American rubbers, Ceara (*manihot Glaziovii*) continues to interest planters by its rapid growth, ready propagation, tenacity of life, and early production of seed. From this latter quality chiefly it has resulted that the loud and urgent demand for seed has almost ceased in Ceylon in the course of one year. We have distributed it to several private planters in India and to the Government establishments there, also some to Singapore for a further trial, as well as to Jamaica and other colonies.

A single tree of *Hevea* flowered at Henaratgoda and produced a few capsules in April. The growth of Para rubber is not rapid; our largest is now 21 inches in circumference at a yard from the ground, an increase of 5 inches in the year. New plantations of *Hevea* have been formed, and some trees at Peradeniya have been planted in a position in the new garden where they are flooded when the river is high, with a view to an imitation of their native habitat.

One plant of another species, *Hevea Spruceana*, which gives valuable rubber, was sent direct from British Guiana by Mr. Jenman, but has unfortunately not survived.

At the request of the Government of India—at whose expense the plants were originally imported to Ceylon—a consignment from Henaratgoda, consisting of 28 good stocks rooted in a Ward's case, was despatched (from Henaratgoda) in November to the Andaman Islands. The climate there is likely to prove eminently suitable for Para rubber which has not succeeded in Peninsular India, but is going on well in British Burmah.

The *Castilloa*, both at Peradeniya and Henaratgoda, also produced flowers during the dry weather of April; on examination, however, these were all male. This species is said not to produce seed till eight years old. The finest tree at Henaratgoda has now a stem of about 22½ inches in circumference at a yard from the ground.

During the early part of the year I made a preliminary and tentative investigation to ascertain the condition of the milk in our Ceara trees at Peradeniya, and the best means of obtaining it. The principal conclusion I arrived at was that the trees had not their milk in a sufficiently concentrated state to invite tapping. I was quickly led to the opinion that the method of paring the stem as practised by the natives in Brazil (according to Mr. Cross) would not be found either convenient or economical. The milk-vessels occur in two layers, the richer one is in the innermost stratum of the bark just outside the cambium, but there is a smaller one immediately beneath the thin green layer; this latter is sacrificed by the slicing process which also causes loss from the milk adhering to the shavings. In the culture of this kind of rubber the principal difficulty will, I think, be the *extraction* of the milk. It appears to be present in good quantity, but a very small amount flows from each cut, and it is difficult to avoid drip and loss if the stems are not perpendicular. It is not possible at present to make any estimate of the slightest value as to the probable average yield of a tree. The plant is evidently very hardy and rapidly recovers from bark injury. I think I should repeat here what I said two years ago (Notes p. 4) that the yield of a few trees cannot be remunerative, and only large plantations can hope to repay the cost of collection. The quality of the *dry* rubber (resulting from milk laboriously obtained from one tree by small incisions) appears identical with the Ceara scrap of commerce, in spite of the extremely watery character of the milk. Further experiments will be shortly made.

The more valuable Para and Central American rubbers have their milk already in more concentrated condition than the Ceara; *Castilloa* especially

affords a milk which spontaneously coagulates in a few hours into a very elastic rubber. Mr. Cross states (Report to Madras Government, March 1881) that a tree of *Castilloa* 1½-2 feet in diameter if carefully and judiciously tapped should yield about 12 lb. of rubber per annum; and with regard to *Hevea*, Mr. Wickham, who brought the seeds from South America to Kew, informs me "it bears tapping very well if properly worked, and I have known productive Ciringals (rubber walks) the property of several generations of Indian Ciringaros. In their native woods the large trees (they grow to a great size) are selected for working as being profitable by taking a large number of cups or a long vine band, but were a plantation formed the trees could no doubt be profitably worked whilst still small—say 24 inches in circumference. The great thing is to avoid cutting too deeply into the bark."

Gutta Percha.—A plantation of the "Gutta Sundek" from Perak has been formed in the new garden. The trees are healthy, but, like all their tribe, grow with extreme slowness.

INDIA-RUBBER: IMPORTS, EXPORTS AND DESCRIPTION.

(From the *Gardeners' Chronicle*, April 8, 1882.)

According to Messrs. Hecht, Lewis & Kahn's report for 1880, the total imports of Para rubber (Hevea) into England during the year was 3768 tons, of which 3661 tons during the year went into consumption or was exported. Liverpool received 35 tons of Ceara scrap rubber (Manihot), 100 tons of Guayaquil and Carthagena (Castilloa) most of which found its way to the United States, and 1300 tons of (West) African (Landolphia), of which "all kinds were readily taken by consumers and exporters," notwithstanding an increase in the imports of the year of 400 tons. London imported 370 tons from Assam (Ficus), 530 tons from Borneo (Willughbeia), and 900 from Mozambique (Landolphia).

The constant demand for caoutchouc for manufacturing purposes, and the efforts made by the Government of India to foster the cultivation of rubber plants, especially the South American kinds, has turned the attention of planters in our tropical colonies to the subject. A rather active correspondence has sprung up with Kew for information as to the little investigated native sources of commercial caoutchouc other than the South American, which has been so prominent a topic in preceding reports. A considerable body of information, especially regarding rubber yielding plants of the natural order Apocynaceæ, has gradually accumulated, as the result of inquiry, and this has been carefully examined by the Assistant-Director, who proposes to communicate the more strictly scientific results, with descriptions of the new species, to the Linnean Society. The following abstract of the economic aspects of the subject will, I trust, be found useful by our colonial and Indian correspondents. It is arranged under geographical heads.

Africa.—All the present commercial sources of African caoutchouc belong to the genus Landolphia. This is a group of woody climbers, all of which probably yield caoutchouc peculiar to Tropical Africa and the adjacent islands. African caoutchouc comes into commerce both from the west and the east coast, and only one of rubber-vines is common to both. The following are the rubber-yielding species at present known:—

West Coast.—1. L. owariensis is apparently the species possessing greatest latitudinal range, the genus Landolphia was founded upon specimens of it collected in Oware by Palisot de Beauvois, and it extends from Sierra Leone, where it was collected by Don, to Angola, from which Kew possesses specimens from Welwitsch and Monteiro. It was collected on the Niger by Barter, and near the mouth of the Congo by R. C. Phillips (who states that it bears the native name of Mvoochi). A form not specifically distinguishable, was found by Schweinfurth in North Central Africa. He remarks (*Heart of Africa*,

i. 192) that "it is well known in the Guinea trade for its production of caoutchouc." From the fruit "the sourness of which exceeds that of the Citron," the natives of Djur-land manufacture "a beverage refreshing as lemonade."

The plant figured by Collins (*Report on Caoutchouc*, pl. 4) as L. owariensis, differs, especially in its minute flowers, from the species as defined by Palisot de Beauvois, and is possibly founded upon materials belonging to some other.

2. *L. Mannii*, sp. n.—A very distinct species, collected by Gustav Mann at Corisco Bay (lat. 1° N.), and not at present known from any other locality. Mann describes it as a climber 20 feet high, and yielding caoutchouc.

3. *L. florida.*—This beautiful species, originally described in the *Niger Flora* by Bentham, appears to be distributed over the whole of Central Tropical Africa. Its heads of large sweet-scented jasmine-like flowers would render it a desirable introduction, from merely a horticultural point of view, in stove-cultivation. On the Niger, according to Barter, its fruit, which is very sour, is eaten by the natives under the name of Aboli. According to Monteiro, who collected specimens in Angola, the indiarubber of Southwest Africa is derived from this.

Further information on the subject of Landolphia florida may be found in Thomas Christy's *New Commercial Plants* (No. 1, accompanied by a good figure) as well as below, amongst the East Coast species. *Report of Royal Gardens, Kew*, 1880.

QUESTION ABOUT INDIA-RUBBER.

To the Editor "Ceylon Observer."

Dear Sir,—Being interested in the cultivation of rubber, I shall be exceedingly obliged, if you, or any of your correspondents, will inform me how long the Mozambique pink rubber (*Landolphia Kirkii*) takes to come to maturity. If, as a correspondent in the *Observer*, of the 29th March, hints, it is closely allied to the Para rubber, probably it will take nearly as long to come to maturity, which is, I believe, about ten years. In that case, will it not pay planters much better to stick to Ceará rubber, from which there is a good return two years after placing the seed in the ground? I have just been tapping a Ceará tree only six months old from which I collected a small ball of rubber. The tree is very hardy and seems to stand wind remarkably well.—Yours faithfully, Ceara Rubber.

CEARA RUBBER: TAPPING THREE TREES 18 MONTHS OLD.

31st May 1882.

Dear Sir,—I send by this post an egg of Ceará rubber milk, which was taken by myself and a cooly within 1-30 to 3-40 p. m. on Gondennawa estate in Nawalapitiya. My cooly Muttusamy, says that they will have a luck in feature in collecting rubbers under green shade; it seems that coolies are very fond of collecting rubbers.

I think within a few years our old Ceylon will beat Ceará in its rubber. So, dear editor, please let us know your remarks on this egg of rubber and oblige, yours obediently, J. P. Abraham.

[The "egg of rubber" is as tough and elastic as could be wished, and the colour seems good. There is some moisture on the surface, which has a powerfully acid smell. We shall send the specimen to some one better able to judge of its quality. Meantime we hope Muttusamy cooly may turn out a true prophet as to the "feature" of Ceylon in regard to rubber. So many electric telegraph cables are being laid that a large demand is likely to continue for the gum.—Ed. C. O.]

INDIA-RUBBER AND GUTTA-PERCHA IN THE FAR EAST.

(From the *Colonies and India*, 12th May, 1882.)

Dr. L. Pierre, Director of the Botanical Garden at Saigon, in French Cochin China (about the same latitude as Tenasserim), has recently made some interesting observations on the rubber and gutta yielding trees of Cochin China and Cambodia. in No. 2 of "Cochin Chine Française: Excursions et Reconnaissances," an official work published at Saigon.

Siphonia elastica, introduced *via* Java, is apparently certain of establishment, thought not yet seriously cultivated; *Ficus elastica* has also been introduced. It is, however, to the indigenous plants that Dr. Pierre's attention has chiefly been directed. He speaks of three native species of *Euphorbia*, not worked by the inhabitants of the country, though easily cultivable, and growing on the driest and most unlikely soil, which afford a medium or inferior product, and are considered to be worth the attention of the Government; and he also mentions an allied plant of very wide distribution and rapid growth, *Excœcaria oppositifolia*, which furnishes a most abundant milk. But the most remarkable plant in Cochin China, from the caoutchouc-producing point of view, is one of the *Apocyneæ*, *Parameria* (or *Ecdysanthera*) *glandulifera*, on which positive and entirely conclusive experiments have been made. This plant is a liana or creeper, which grows to the tops of even the highest trees, and is found abundantly in all the forests of Cochin China, chiefly at Cam-xay. Phuquoc, Poulo-Condore, and in the environs of Tayninh, Baria, and Bienhoa, being excessively common near Xong-luu (we retain the original spelling): nevertheless, the natives do not know how to extract the rubber from it.

The diameter of this creeper when full grown (say in ten years) is nearly two inches. The juice that flows from it presents exactly the appearance of milk, and can be used like it, having a slightly nutty flavour. In its liquid state it is often employed as a medicine by the Annamites and Cambodians. The bark, after being dried (usually by fumigation) is sold at the rate of from 20 to 25 frs. the picul (133 lb.) and sent to China, where its medicinal properties are much appreciated. It is to be had in all the markets of Cochin China under the name of "dau" or "dô tam" in the Annamite, and of "wâhrr angkôt" or "whole angkôt" in the Khmer language.

The method employed for the procuring cautchouc is of the very simplest natnre; it is only necessary to pour the juice drawn from the creeper (either by incisions or cutting it up into small lengths, if a larger quantity is wanted at once) into a basin of water of the temperature of 40° or 50° (presumably centigrade, equivalent to 104° or 122° Fahr.), when, on being stirred with a rod, the milky mass is instantly converted into an excessively pure rubber of unrivalled quality.

This plant is propagated by cuttings with astonishing rapidity. Introduced into the botanical garden at Saigon in 1874, it had, by climbing up trees, reached in 1877 a height of from 26 feet to 33 feet. It could be planted so as to economise space without harm under any forest tree not less than ten years old, when the now devastated forests of Cochin China are regularly taken in hand; or it could be trained at the foot of fruit trees grown as hedges. In this way the almost entire want of any necessity for cultivation, and the double utilisation of land generally considered worthless, would combine to render the plant the source of a very paying revenue.

As to the now possible working of the creeper as it grows in a natural state in the forest, the only way would be to apply to the Chinese and the native traders (especially the Cambodians), who for an adequate offer would collect the juice. It is solely a want of care and the present state of infancy of French commerce which have caused the product of so valuable a plant to be hitherto neglected, says Dr. Pierre, who mentions among other *Apocyneæ* in the Botanical

Garden a species of *Willughbeia*, very vigorous and a rapid spreader, and yielding a very abundant juice, though its rubber is possessed of but slight elasticity.

As Indiarubber is apparently now increasing in market value, it may be worth the while of our settlers in British Burma and the Straits Settlements to pay careful attention to the rubber-yielding Apocyneous plants growing wild in those countries, which are in about the same latitude as Saigon, and present similar climatic and geographical conditions, being also parts of the Indo-Chinese peninsula. Economic botany has not been neglected in them, it is true; *Ficus elastica* has been introduced into British Burma and thrives as far as mere growth goes, though it is yet too early to judge whether it will retain its quality out of its natural limits. *Chevanesta esculenta*, a caoutchouc-yielding creeper, has also been planted in the Ma-ga-ree Forest (British Burma) and grows vigorously; but it is to the native plants that attention could apparently be profitably turned, and of these, *Ficus laccifera* (in Burmese "Guyoung"), which grows in the evergreen tropical forests of Pegu and Tenasserim, is stated to yield a very good rubber, equal to that of *Ficus elastica*; and there are many other native species of *Ficus* and *Artocarpus* yielding caoutchouc of different qualities. Another plant, *Isonandra polyantha*, found in the forests of Arakan, yields gutta percha probably not inferior to that of Singapore (according to Spearman's *British Burma Gazetteer*, 1880); but it is evidently to the resinous gums that most attention has been paid by Colonial botanists here.

As regards gutta-percha, Dr. Pierre points out the present state of uncertainty as to the exact trees which furnish the very varied qualities of that commodity coming into the market under the names "Macassars," "Borneos" "Sumatras," "Banjermassins," and "Singapores"—purely commercial designations, which afford no indication of the local origin of the species. "Borneos" are known to be inferior, but the others are subject to great variation; and it is a curious thing that no collectors, Chinese, Malays, Dyaks, or others, can be induced to supply specimens of the trees which furnish the gutta they bring. Hooker's original gutta-tree, brought by Lobbe from Singapore, and described as an *Isonandra*, is now known with certainty to be a *Dichophis*; but it is still not known whether this is the tree that supplied the best commercial gutta, for wheih the southern part of the Malayan peninsula, Borneo, Bantam, and the neighbouring isles, must probably be searched. The only commercial gutta really traced to a tree is that obtained in Larut by Messrs. Brau de St. Paul Lias and De la Croix, through Mr. Low, our Resident at Kuala-Kangsar. The tree from which this came is figured by Dr. Beauvisage under the name of "Gueutta seundek," and is supposed by him to be the *Keratephorus Leerii* of Hasskarl, which is now known to belong to the genus *Payena* a Sapotaceous plant. Dr. Pierre notices another species of this genus *Payena alabasterana*, from the right banks of the Mekong; also a *Bassia* (called "Sang dao"), a *Mimusops* (probably *M. Rauki*), *Chrysophyllum Roxburgii*, two species of *Sideroxylon*, and *Dichopsis krantziana*, as indigenous plants worthy of investigation as yielders of gutta-percha; and he concludes with pointing out the great commercial and economic importance of scientific observations in this direction, in language equally applicable to British Colonies in the Far East.

ADDITIONAL INFORMATION.

(Compiled for Second Edition.)

INDIARUBBER.

The *European Mail* and the *Planters' Gazette* each contained short notices of the recent discovery made by Mr. Jenman, the Government Botanist and Superintendent of the Botanic Gardens, of two new India-Rubber, and Gutta-Percha trees in the interior, and his report on these has now been published in the *Official Gazette* by the order of His Excellency the Governor. Our readers may remember that Mr. Jenman wrote a previous report on the Hevea Spruceana, which was published last year, and the present one may be considered to be supplementary to that. Then the Essequebo and Mazzaruni Rivers, and the creeks connecting with these, were the localities described, now he takes us to the Pomeroon River, and gives a most interesting account of his operations there. From his description the Hevea, or Hatie,—the Arawack name of the tree, and the one most generally known by the River residents,—is very similar to the Para rubber tree, attaining about the same dimensions, and growing precisely under the same conditions. Low lying ground, frequently under water during the wet seasons, and densely shaded, seems to suit them best, as where these conditions most uniformly prevail, in the localities where they are found, most of the trees occur. The Hevea, at its best, is not a large tree, rarely exceeding twenty inches in diameter, and squaring for timber to about fourteen or fifteen inches. The bark is thin and smooth, and on trees, a foot or more in diameter, it is not more than a quarter of an inch thick. "When found in high forests, surrounded by others, the trees are quite straight and erect, and attain a height of sixty feet or more, with a few branches at the head." As to the rate at which the Hevea grows, Mr. Jenman can only adduce evidence gathered from the residents of the rivers and forests of the colony. An intelligent lad, a half breed, who has been acquainted with the tree from his youth estimated "speaking of it, of course, in its native habitats, that it attains a diameter of eight or nine inches in five or six years." This Mr. Jenman considers must be its extreme rate of development under the most favourable conditions; still it is a sufficient guide to those who may entertain Mr. Jenman's advice to undertake the cultivation of the tree in some of the many localities suitable for its growth.

These will be found on all the rivers of the Colony below the falls, and will thus be accessible without difficulty or expense. "The cultivation might be successfully pursued, not only where the trees are found spontaneous, but, as well, on land of a similar or identical character, though in which, through other circumstances, they are not naturally established." The labour required would be very inconsiderable, and a few hundred acres, treated with care and intelligence, would prove, in the course of years, a source of considerable means to the proprietor. "If planters in Ceylon and India speak hopefull sa they do, of the eventual success of Hevea cultivation in those countries, here possessing all the natural conditions, and the advantages derived from an

intimate acquaintance with these under the actual occupation of the trees, the success should be assured. Wherever the tree is found, in the fruiting season —April to June—seed may be procured in fair abundance. If sown at once under the trees in nursery beds prepared from the lighter soil and leaf-mould which the forest affords in places, the plants would spring up rapidly, when they might be carefully lifted, with their rootlets unbroken, and planted at intervals under the other trees. Where the latter are too close to admit the amount of light required, they should be thinned out first; and it might be necessary to carry this on with care from time to time with the increasing requirements, both for room and light, of the planted trees. In some seasons and places it would be unnecessary to collect and sow seeds as natural seedlings may be gathered under the trees."

The Hevea cultivator should be prepared to wait for his crop, but meanwhile any trees already on the ground might be utilised, and the produce sold. Seeing the increasing demand for indiarubber, with the daily extension of its application, and particularly the value of Hevea rubber, as compared with other kinds, the results of the enterprize might be looked forward to with the utmost confidence. Manufacturers will take all they can obtain, and were it only more abundant in the market and cheaper, many new uses might be found for it. "To give an idea of the importance of the Brazilian trade in rubber, I may mention that the export from Para for the half-year ended June last reached the value of R12,350,000. It illustrates, as well, the value of the industry which is within our reach. The present market value of Para rubber is 4/6 per lb. The cultivation might be carried on in conjunction with woodcutting, plantain growing, or any other immediately remunerative industry which would enable the cultivator to tide over the time till the trees reached the age of production."

Having shown how the tree may be cultivated, Mr. Jenman next deals with the yield, and the method of collection. From experiments on good trees he has come to the conclusion that each cut may give half a cupful of juice, there being 15 cups to the English imperial pint. The chief difficulty seems to be in the method and means for collecting the juice, and for this purpose he recommends cups that are round or flat, or slightly concave; the latter being the best as they fit more closely when pressed against the tree. They are made of burnt clay and can be readily obtained at a cheap rate from Caribisci Indians, being fastened to the tree immediately under the incision made by the collector's axe, by a small lump of well-wrought clay. In the Pomeroon where the tree grows, he found a very suitable clay which he employed in his operations. "Nothing is gained by making numerous cuts close together; the flow of juice should be allowed to take place by a few rather than several exudations. If it occurs from too many for a certain area, so little is obtained from each as to be a mere drop or two in a vessel, which, diffused over the large surface of the several receptacles, involves a proportionately large loss by surface adhesion, in addition to the time and labour taken up by extra work. A circle of incisions is made each day, extending from as high as one can reach, and working downwards day by day to the base of the tree. They should be made about six or eight inches apart; the incisions in the circles being in quincunx order."

Mr. Jenman then goes on to describe the new tree which he discovered in the Pomeroon, and which he regards as of "great interest and importance." The tree appears to be a species of *Ficus Urostigmia*, but in the absence of flowers or fruit it can only be identified conjecturally, and he adds "the colony abounds in different plants of the above given, of which presumably other species to this are also valuable," some of them being known to attain large dimensions. The method of collection seems very simple. The bark is cut and then left, and the milk which oozes from the wound dries in a few days. This

is then stripped from the bark, and rolled up in the shape of a ball, the rubber being exceedingly strong and tenacious. "This method of collecting is that pursued in Ceara, the province of Brazil, which produces *Manihot Glaziovii.* It is very economical of time, for it saves the tedious operation of catching the milk in a vessel as it issues from the wound, which is the most bothersome of all the operations. The principal objection to it is, that the rubber becomes soiled by the dirt adhering to the bark, a little of which it retains, and no doubt this would deteriorate its market value; but this cause of depreciation might be reduced to a minimum by carefully brushing the surface down prior to commencing collecting operations." "The Indians know the tree under two names, the *Carabisi* calling it Touckpong and the *Arawacks* Cumakaballi. Noble in all its proportions, spreading and lifting its massive head above its neighbours, it is one of the largest trees of the forests, and has a wide and general distribution over the deep belt of low lowcountry in the colony. Samples of the rubber of both this and the Hatie, I have sent to England to be tested as to their probable commercial value." An attempt was made by Mr. Francis to extract indiarubber from the bark, but with no practical result, as the amount obtained was only three per cent of the quantity treated, and this quantity would never pay for the cost of extraction.

The report concludes with a wholesale condemnation of "the nefarious acts of traders and others" who induce the Indians to cut down rubber-bearing trees for the purpose of obtaining their juice. The Indians should be held responsible for this on detection, and "much more should the men who instigate them to it, for their own profit, knowing that they could not do it with impunity themselves, be severely punished for their villany." From the products of our forests which are utilised, important as they undoubtedly are, the colony derives hardly any profit, while the forests are impoverished by wanton waste, and the depredations of the dishonest, and the trade is in the hands of a few merchants. As to the balata trade, unless some efficient method of utilising the whole of the bark be discovered, felling should be prohibited, and, if with this rule, an export tax were imposed, and every package containing the gum required to bear a special brand belonging to the grant on which it was gathered, which would show the production of each grant, a very salutary change would be effected in the trade." All right-thinking people will agree with Mr. Jenman in the above remarks, and heartily endorses his proposals for improvement. It is not only in Indian-Rubber and Ballatta this is required. Large quantities of Locust Gum, Tonquin Beans, and other products of the interior are now being exported from the colony, collected principally on Crown Lands, and which do not contribute one cent to its taxation. Mr. Jenman deserves the thanks of the entire community for the discovery he has made, and for the valuable information his report contain.—*Demerara Gazette.*

THE INDIA-RUBBER AND GUTTA PERCHA TREES OF BRITISH GUIANA.

At a meeting of the Royal Agricultural and Commercial Society of British Guiana, the Secretary laid over a communication he had received from Mr. Jenman with regard to the India-rubber trees in Demerara. The letter is as follows:—

My dear Sir,—I enclose herewith for the Museum of the Royal Agricultural and Commercial Society, samples [vulcanised] of india-rubber, produced respectively by the Hatie and Cumatraballie of this colony. The raw rubber from which these samples were manufactured, I collected on the Pomeroon River, and sent to Kew, to be tested a few months ago; which resulted [with other correspondence] in the following report, communicated through the Secretary of State for the Colonies and published in the *Official Gazette*:—

" The india-rubber made on the Pomeroon River, British Guiana, from the *Hevea Spruceana* contains caoutchouc, but is impregnated with other principles which destroy its properties for any manufacturing purposes involving the process of vulcanizing. Since most of the species of *Hevea* have been described as yielding good india-rubber, including the *Hevea Spruceana* growing several miles north of the Amazon, it would be important to determine whether in this case the deteriorating principles are foreign [? belonging] to the tree, or whether they arise from injudicious incision. The rubber smells very strongly of the oily matter which goes off in the smoke from the burning of the nuts of the Uracapi palm, which also has the effect of softening and rendering the rubber dark.

The loss on washing and drying is 11·75 %. The soft and sticky character would appear to be due to a volatile, or perhaps easily carbonised substance. When mixed with sulphur and submitted to the vulcanizing processes, it vulcanizes, but becomes spongy. The caoutchouc vulcanizes so completely, that it would be worth while to try whether by any chemical treatment its sponginess can be prevented. Such treatment, however, prevents its being used extensively.

" The [Cumatraballi] india-rubber on washing and drying yields a loss of 14·96 %, and when mixed with the suitable proportions of sulphur, vulcanizes perfectly. Its firmness and freedom from stickness are in favour of its manipulation.

The passage in the report,—" it would be important to determine whether in this case the deteriorating principles are *foreign* to the tree, or whether they arise from *injudicious incision*" is not very clear in its meaning. Injudicious incision, so far as it affected the character of the milk, would be "foreign" to the tree; but I do not see how any method of tapping could be injudicious in this sense. In collecting this rubber, the incisions were made with a cutlass; and an axe or this instrument must necessarily be used in the operation. It is true the juice was dried in the smoke of burning palm nuts, but this system is very largely practised in coagulating Para india-rubber. It hastens the process, but is not essential, and need not be pursued if disadvantage pertains to it.

It is disappointing, however, that as *Hevea Spruceana* is so abundant in the colony, and such a near ally botanically of the valuable *Hevea brasilensis*, its rubber should be, apparently, of such inferior quality. I say apparently advisedly, for I think this cannot be regarded as determined till the nature of the deleterious principle, which prevents its perfect induration when vulcanized, is ascertained, and whether it was accidental in this sample or is inherent in the juice of the species of *Hevea*. It is possible, too, that if the sponginess cannot be prevented in its manufacture, considering the multiplicity of the applications which are being found for india-rubber, certain uses may be discovered for which this character will specially recommend it, which seems not improbable, for it is certainly a very peculiar and characteristic substance.

As I anticipated in my report of the discovery of the Cumatraballi,* its rubber has proved to be an excellent material; and considering the great size of the tree, its thickness of bark and prolificness in milk, the price [2/3-2/6 per lb.] it is estimated as worth in the market is very satisfactory and encouraging; and I have no doubt that in the future both the trees and the rubber which it yields will be in considerable demand. I hope in the interval steps may be taken to prevent collectors from felling and destroying a tree so valuable, and of much interest for its grand proportions as a woodland feature, and thus ensure its abundant perpetuity in the colony.—Very faithfully yours, —G. S. JENMAN.

W. H. Campbell, Esq., Secy., Royal Agricultural and Commercial Society.

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*Report of the Government Botanist and Superintendent of the Botanic Gardens on some of the India-rubber and Guttapercha trees of British Guiana, —*Gazette* Office, 1883.

RUBBER CULTIVATION IN CEYLON: SUCCESSFUL COLLECTION OF THE PRODUCT:

GILLIAT'S CUTTER, TINS AND PROCESS OF ELIMINATION.

Another clever contrivance has to be added to the long list of inventions by Ceylon planters for the more rapid, economical and successful performance of the work connected with the cultivation and preparation of New Products which, of recent years, have excited so much attention. But first of all it is satisfactory and reassuring to find Ceará Rubber trees brought forward again as objects promising financial success for the cultivator. So much was said lately of the difficulty of collecting the milk—or rather watery substance—to make it pay, that on many sides the cry was heard that Ceará Rubber trees were no good, and could not be made to pay, whatever might be the case with the other varieties. The Ceará trees to which the following experiments refer are growing on Peradeniya Estate from 3½ to 4 years old, 28 to 34 feet in height, planted 12 feet by 12, and already with their branches so interlocked that there is dense shade beneath. Mr. Gilliat, the manager, has a strong opinion from the result of his observation and experiments that shade is inimical to the quality of the rubber got from the stem and he would recommend planting 15 by 15 feet or even 20 by 20 as an experiment. Again he has found that the best time to cut or tap is immediately after rain, and Dr. Trimen fully agrees that the flow of sap will be greatest just before the flowering season.

The great *desiderata* hitherto with all who have experimented with rubber trees in Ceylon have been a satisfactory, economical mode of tapping the tree without injuring it, of collecting the milk and of securing it in a marketable form without the admixture of foreign substances or impurities of any kind. Mr. Dobree's knife was intended to be used for the removal (and replacement) of a portion of the bark—an operation which could scarcely be done without injuring the cambium. Mr. Wall tried skinning the tree and then pricking it to induce the flow of the milk—a tedious and expensive process we should suppose. Certainly we have seen no instrument and heard of no means of tapping equal to that which Mr. Gilliat (the inventor) brought under our notice today. By his little instrument, with the accompanying tins and the process for the elimination of impurities, we are very hopeful, Ceará Rubber cultivation may be made a very profitable branch of New Products' Industries in Ceylon and we trust Mr. Gilliat's ingenuity and patient experimentalizing will meet with the reward they deserve. Suffice it to say that a cooly with this little knife can make the requisite number of cuts down the bark of the rubber trees with ease and rapidity, without any material injury to the cambium. When made, the cut is about ⅛th of an inch open or wide by 1-16th inch deep: the cuts should not be nearer each other than six inches—that is trees on Peradeniya, four years old, 24 inches, girth takes four horizontal cuts; but Mr. Gilliat is very hopeful (and Dr. Trimen we believe agrees) that after a month's interval, four more cuts in the intervals may be made without injuring the tree, so given a second harvest of rubber. An ordinary cooly can go over 200 trees a day with 4 cuts in each, and a little podian can follow with the tiny tins (specially made by Mr. Gilliat out of empty kerosine tins) which are stuck into the tree to catch the exuding rubber. Those tins can be made at 5 cents a piece. The most important part is however the chemical process by which all impurities are precipitated and lumps of pure white rubber, gradually assuming the pink colour on the edges so prized at home, are secured. Mr. Gilliat being more or less of a chemist, had experimented for months over this, until he found the spirit, a very little of which dropped into the day's gathering of rubber, secures the above result. The elimination is secured even if 24 hours elapse between the tapping and the application of the spirit. Dr. Trimen is highly satisfied with the result; and we cannot help thinking that the beautifully white clean samples of rubber shewn to us today will be priced as high as

any in the home market. Mr. Gilliat is to lay them before the Planters' Association. So far as his experiments have gone, from $\frac{3}{8}$ths to $\frac{1}{2}$ ounce of rubber per tree is about the gathering or say $\frac{3}{4}$th ounce from the two cuttings with a month's interval. No one can yet say how soon the tree will bear another harvesting. The experiment has to be made; but there is no reason to doubt a satisfactory profit from rubber cultivation, when harvesting and preparation are done with the instruments and according to the plan invented by Mr. Gilliat of Peradeniya estate to whom all rubber planters owe, at least, their best thanks.

RUBBER CULTIVATION IN CEYLON.

(From the Proceedings of the Planters' Association at Kandy.)

Friday, 21st September, 1883.

Mr. GILLIAT said a great deal had been said about the possibility of producing ceara-rubber in such a form as to send it home to make it best pay. He would now venture to lay before the Association samples he had succeeded in getting during experiments he had been making lately on the Peradeniya estate by the courtesy of Mr. Huxley who was manager there. He had invented a knife, which he was not in a position to show publicly yet, but it would soon be ready and he hoped it would meet with the approval of rubber planters. By this knife there is no necessity to remove the outer bark, and the cut can be made straight down as high as the operator could reach. A cooly simply got up the tree, and, placing the knife as high up as possible, took one straight cut down the tree within 3 or 4 inches of the ground. Dr. Trimen was present at the first trial and he expressed his satisfaction with it. He had partly invented a tin to be placed underneath. Dr. Trimen is of opinion that there is little or no injury done to the cambium which he thought, they ought to avoid. The milk flowed very freely and it was then collected by a cooly and by a certain process he took out all that crude rubber oil which was a constant source of trouble to planters. By the elimination of this crude oil the rubber, he believed, could be landed in England perfectly white. In his first experiment he succeeded in getting $\frac{3}{8}$ of an ounce to one tray, from a tree $2\frac{1}{2}$ years old.—Mr. Huxley was present and he would correct him if that was not right. The operation might be repeated in 30 days. On his return from Colombo the other day, it struck him that he would try another experiment on his trees that he had experimented on 9 days before and the result was most satisfactory. He had $1\frac{1}{8}$ ounces on the second tapping, in 9 days. The argument against it would be that the punishment to the trees would be too great to go on at that for any length of time, but he considered that if the trees were of fair age, say 3 years, and of vigorous growth, it might be possible to tap them every 30 days. But this as all in its infancy and he could not guarantee that. It was certainly satisfactory to know that the milk flowed so freely. On Wednesday last he tapped 18 trees in 53 minutes and got 10 ounces of pure rubber. He estimated that a good man and a cooly, fully up to their work, on fair ground, could tap 200 trees a day. He had brought samples for the inspection of his brother planters which he should be very happy to lay before them. (Applause.)

Mr. Gilliat then handed round samples of the rubber he had taken and answered any questions made with reference to them.

Mr. HUXLEY said he might say he tapped three trees and each took five minutes, and in that time he got from them $3\frac{1}{2}$ ounces of rubber and also over half an ounce of refuse rubber, and one of these trees he had tapped three days before.

Mr. GIBBON:—May I ask the age of that tree?

Mr. HUXLEY: It was four years old.

The CHAIRMAN (Mr. WALL):—I think we are very much indebted to Mr. Gilliat and Mr. Huxley for the information they have afforded us. This is a subject which has been hitherto rather a perplexing one and one of which there has been no definite solution arrived at. I have myself personally given a great deal of attention to this matter and I arrived at the conclusion—very probably a premature one—that any plan that materially interferes with the bark, especially anything that cuts through any length of the bark, even though it should not cut into the cambium, is very objectionable. I have trees so treated, perhaps severely, a year ago and those trees are scarcely of any value at all owing to the difficulty of tapping the bark that has been renewed over the wounds. The experiments I have hitherto made are not of a nature to justify any conclusions. The experience of a life which has been in a considerable measure devoted to experiments of a scientific nature has taught me not to draw any conclusions until the matter has been under my notice sufficiently long to justify some conclusions. The efforts I have made have been in various directions, I have used tools of every kind, and given them all up. In the first place I have endeavoured, without cutting deeply into the bark at all to take a slight shaving off. The object of that was to lay bare as many of the lacteals as possible without making any injury to the bark, and I found so far as my experiments went that I could get no more milk from the portion that was laid bare to a considerable area, than I got by a cut, and when I tried trees of the same age which had been grown in the same soil and which were in fact, contiguous to each other, I found to my surprise, that the pricking of the bark, without any other interference,—I have employed a pricker somewhat resembling a comb but much larger, and having its teeth more asunder, and by a single stroke of the pricker, which has a handle on to reach from the top of the tree to the bottom,—I found I got as much milk from these punctures as I did from the cut in the bark, or from the exposure of the lacteals. That is the result of any experiments so far as I have carried them. I therefore have looked upon it as almost a settled question in my own mind that if you can get by a puncture a sufficient quantity of milk, especially if you get as much that way as by a cut, you may repeat the operation much more frequently and with much less damage to the tree. Visiting trees I had tapped the morning previous, I found them on the following morning, as far as could be seen, to be perfectly healed. The experiments with the prickers and the results of them will be laid before you as soon as they are ripe for it, to see how far this mode of extraction can be carried out. There is no doubt that with regard to the preparation of the milk we are deeply indebted to whomsoever it was who suggested the application of a little spirit, for it is marvellous how quickly and effectually it operates. Up to that time our plan was to take a cake of milk and after it had congealed sufficiently to bear a little pressure, to give a little squeeze and this squeezed out the fatty matter which impairs the value of the rubber, and this can be repeated till the rubber assumes a hard and merchantable form, but I am not prepared to say it is so white or pure as this (referring to a piece of Mr. Gilliat's rubber). The experiments our brother planters are carrying out will be most important, and, as I said before, as soon as the result of my experiments is such that I can offer it to you with confidence, I shall be very ready to do so, but in the meantime I only report progress up to date. I am sure the meeting will join me in thanking Mr. Gilliat and Mr. Huxley (cheers.)

Mr. GILLIAT:—There is one point I have missed, and that was to tell you that we cannot say whether any profit can be made on it until we have a quotation from London. It seems to be impossible to get one in Colombo; of all our merchants we have not one who is an expert in rubber. I tried on Monday in Colombo but there was no one who could give me a quotation, and so it was sent home and we shall get a quotation from London. We know there is no injury done to it by this process. Of course I shall be very happy to lay it before the Association when everything is ready.

THE INDIARUBBER SUPPLY FOR THE UNITED STATES.

The increase in the consumption of indiarubber in this country has been very large within t' e past ten years, and more particularly within the letter half of the decade. This is owing both to the great increase in the consumption of rubber boots, shoes and clothing consequent upon the increase in population and to the multitude of new uses to which rubber has been put to the almost total exclusion of the horn.

Our imports of indiarubber are classed together with gutta percha, both being on the free list and being to some extent similar articles. They amounted to 21,646,320 pounds in the fiscal year ended June 30, 1883, and valued at $15,511,066. By far the larger portion was indiarubber. Our imports from Brazil alone footed up $8,600,000 in 1883, while we imported from Central America, United states of Columbia and other South American countries to the value of about $3,000,000, and African indiarubber imported for the most part via England foots up about $2,000,000.

The great bulk of our supply, however, and the best rubber also comes from Brazil, where its collection and preparation in crude state for shipments forms the principal resource of the two great provinces of the Amazon Valley, Pará and Amazon.

Next to coffee and sugar, rubber occupies third place in Brazilian exports. Notwithstanding this hardly any thought is given to the future of this great industry in Brazil. The same wasteful and exhaustive system of collecting the rubber which has been in vogue for half a century is followed today. The industry is chiefly in the hands of an uneducated and half-civilized nomad population of Indian mixture, and is pursued in a crude way with no thought beyond immediate profit. In consequence, millions of rubber trees have been destroyed, and many others abandoned from premature and excessive use.

The waste in this way is so great, that many well-informed Brazilians fear that unless better methods are employed, this rich rosource will before many years suffer a serious and perhaps fatal decline. In the few cases where care is exercised in not tapping trees in the months of August and September, when they change their leaves, groves have yielded continuously for 30 years, and are still in good condition,

The rubber tree requires a growth of from 20 to 25 years before it produces the milky sap which forms the rubber. Hence little or nothing has been done to propagate the trees, and everything about the business is carried on as if the supply of trees would never give out. Brazil imposes a very heavy export tax on rubber, amounting, state and provincial, to 22 per cent from the province of Pará and 21 per cent from the province of Amazon.—*Boston Commercial Bulletin.*

INDIARUBBER IN BRAZIL.

The province of Amazonas in Brazil has shown so much liberality in emancipating all its slaves, that we are the more surprized at the petty narrowness displayed in the levying of heavy duties on plants and seeds exported. The legislation is too late to be of any use, but the paragraphs we quote show how important the trade in rubber is to the Province named after the great river, on the banks of which the trees from which the gum is extracted flourish. We quote from the *Rio News*:—

The province of Amazonas has passed a law prohibiting the tapping of rubber trees above 2½ metres from the ground, the tapping of young trees, or those less than 25 years old, and the injury or destruction of young trees. The fine is fixed at $1,000 for each infraction. A premium of $1,000 is offered

for each thousand trees planted and cultivated, at two years of age, besides other favors to cultivators. To guard against foreign competition, an export duty of $500 is levied on every rubber plant, and $100 on every kilogramme of rubber seed exported.

The president of Amazonas sanctioned, on the 11th June, the law guaranteeing 6 per cent on a capital of $500,000 for manufacturing rubber goods.

The receipts of rubber at Pará, in kilogrammes, for the first six months of 1884 were 4,914,516, against 3,566,000 in 1883 and 4,130,000 in 1882.

The official figures for the fiscal year at the Pará custom-house give the total revenue at $10,531,201·650 against $10,707,135·607 in the previous year. This difference arises from the sharp fall in the value of rubber, which from $3,400-$4,300 in the first six months of 1883, gave for the same period in 1884 only an average value of $2350.

The budget law of the province of Amazonas authorizes the president to guarantee 7 per cent interest on a capital of £100,000 at par to a *credit foncier* bank, the funds of the bank to be employed in mortgages on property in the province; also to emit provincial bonds to the extent of $800,000, at 7 per cent interest and 1 per cent sinking fund, to establish a system of sewage in the city of Manáos; also to guarantee 7½ per cent on a capital of $200,000 to establish two mills for weaving cotton, or other textile substance and one for extracting indigo; also to guarantee 8 per cent in gold to a tramway company for 33 years, proposals for which will be called for in the United States and Europe, horse or electric power to be used.

RUBBER HARVESTING EXPERIMENTS IN CEYLON.

It is contended that a cooly will be able to tap in the method proposed by Mr. Wall 300 trees in a day—that is, practically 1 acre—so that if it is gone over daily for 240 days in the year, it will cost R84, at 35 cents a day for collecting alone. To this must be added—rolling in a ball, drying, weeding, and sundry other expenses, which would certainly bring the cost per acre up to R120. If each tree gave half a pound per annum, 150 lb. would be the result for an acre of 300 trees; and were only R1·50 obtained for the rubber, as much as R225 would be the gross income, less R120 for upkeep, leaving R105 as profit. But very much more than R1·50 per lb. should be obtained, and doubtless will be, as the ball rubber and that of Mr. Gilliat has been valued at R2 per lb. By the use of improved methods, which will inevitably suggest themselves as we proceed with the cultivation, not only may the cost of harvesting, which at present is high, be very sensibly reduced, but the quality of the rubber obtained be very much enhanced by the adoption either of some such simple process as "W." alludes to, whereby he obtains the clean looking balls of rubber, or by the use of some cheap spirit such as that used by Mr. Gilliat.

INDIARUBBER AND GUTTAPERCHA IN THE DUTCH EAST INDIES.

We have received a separate reprint of a paper from the February number of the *Tijdschrift van Nijverheid en Landbouw* (Journal of Industry and Agriculture) published in Batavia, the title of the paper being "Over de Toekomst der Caoutchouc-cultuur in Oost-Indië." (On the Future of Caoutchouc Culture in [Dutch] East India), being a notice of a "report on planting experiments with caoutchouc-yielding trees during the first quarter of 1884, carried out by the forester of the forest district of East Preanger, A. H. Berkhout." The review is dated "Batavia, 19th December 1884," but there is no signature, so that we cannot tell who the writer is. He commences by briefly sketching the

history of indiarubber and detailing the uses to which it is put, and then deals separately with the three commercial varieties of East Indian, Sumatran, and American. Under the first, he speaks of *Urostigma elasticum* and *Urostigma karet*, both belonging to the family of the Artocarpaceæ. It seems that Java has the oldest plantation in the world of karet trees, Messrs. Hofland having in 1866 formed an extensive plantation in the neighbourhood of Soebang. The writer goes on to refer to the wasteful method of gathering the rubber, and quotes from the *Tropical Agriculturist* for November 1884, p. 361, an extract on this subject the statements in which, he says, are borne out by experience in Java, and he quotes from Mr. Berkhout's report an instance of this, and then mentions the regulations which are being enforced in Assam for the protection of rubber trees. Details are given of experiments by Mr. Berkhout with karet trees, which seem to promise success. The usual method of propagating this tree is by cuttings, but the writer thinks that the use of seed would be cheaper and more efficacious. Proceeding to speak of Ceará rubber (*Manihot glaziovii*), the writer quotes from Mr. Berkhout's report detail of experiments with seeds obtained from Ceylon in December 1883, through Messrs. John Pryce & Co. Two different methods were employed. A portion was simply put out in the open air between gunny bags and kept constantly moist. To guard against the attacks of ants, which are very fond of the kernels, the bags were placed on rough trestles, the legs of which were put into tins of earth and these into kerosene tins filled with water. Three days afterwards some of the seeds had sprouted, but a large portion after the expiry of a month showed no signs of germination: recourse was therefore had to filing, and the seeds were once more placed between the gunny bags. Many then showed that they possessed the power of germination, but, Mr. Berkhout adds, filing is a difficult operation and if not done carefully causes harm instead of good: if the germ is injured the cotyledons swell but soon rot and no roots are produced. Mr. Berkhout adds that as soon as the seeds begin to germinate they should be planted with the root downwards 1 centimeter (say ½ inch) deep. Seedlings should not be planted out directly in nursery beds, as many would fall a prey to ants, but should be put into pots filled with sand and placed on trestles. When the plumule begins to develop the plant can be placed with the ball of earth in the nursery bed, and for the first few days shaded. The differences in the growth of the plants Mr. Berkhout thinks are to be explained by a portion of the seed being from young trees. Figures are then given of the growth made by plants at different elevations. Experiments were to be tried with cuttings, but Mr. Berkhout considers these doubtful of success, judging by experience with cassava, which is closely allied to Ceará. The writer of the review then quotes from the *T. A.* for last November p. 354, an extract from the report of the Agricultural Society of Madras, giving part of a letter from Messrs. J. P. William & Bros. of Henaratgoda on Ceará cultivation, and directions for the germination of the seed, which he compares with those given by Mr. Berkhout. Passing on to speak of *Castilloa elastica* the reviewer gives an extract from Mr. Berkhout's Report relating to the planting of seeds from a tree in Java all of which germinated, the plants growing well. Mr. Berkhout adds:—"The statement of Dr. Trimen, that the *Castilloa elastica* is destined, under careful culture, to be a source of revenue, appears to me, in view of what I have stated, perfectly correct." Information on the subject is again quoted from the *T. A.*, and then the reviewer proceeds to notice certain indigenous caoutchouc-yielding trees, viz. *Leuconites eugenifolia*, *Beaumontia grandiflora* Wall., *B. multiflora*, F. & B., *B. spec.*, *jav.*, and *Vahea gummifera*, and finally Para rubber. Figures for rainfall at various places in Java are then given, and a table showing the growth of the various varieties of caoutchouc planted. The last plant referred to in the report is a tree called by the Malays *hambarang* (*Ficus fulva*), which yields a vegetable wax, used in the coloring of cloth. The report concludes by pointing out the importance of an extended

cultivation of caoutchouc-yielding plants, now, that the price of cinchona bark has so decreased and the coffee crops have fallen off to such an extent. The writer points out that there is no fear of over-production, as in the case of quinine, the uses to which caoutchouc can be put being almost endless. He calls upon the Government to send a botanist to South America to procure plants and seeds of the best varieties; while at the same time there should be a thorough investigation into the varieties growing in the Dutch East Indies, especially Borneo. So far Mr. Berkhout's report, and the reviewer concludes his remarks by pointing out the difference between caoutchouc and guttapercha, which two substances are popularly confounded together, though entirely distinct in origin, chemical composition and uses. His final words are :—"If, however, the reader wishes to get further information on this subject he should buy the following"—and then come the entire title and list of contents of the book on indiarubber and guttapercha compiled and published by us. For this gratis advertisement and testimonial to the value of our publication we tender our thanks to the anonymous writer.

CHARDUAR RUBBER PLANTATIONS IN ASSAM.

[By Gustav Mann, Esq., Conservator of Forests, Assam.]

I have the honor to submit a report on the Charduar rubber plantations in the district of Darrang, including its past history, the results gained, and a sketch of my views as to the future treatment and extension of that plantation.

2. The past history of rubber plantations in Assam, and, for the matter of that, in India, dates from the year 1872, when Mr. James Collins was charged by Her Majesty's Secretary of State for India to prepare a report on the caoutchouc or india-rubber of commerce, the plants yielding it, their geographical distribution, and the possibility of their cultivation and acclimatisation in India. The only rubber tree indigenous in India *Ficus elastica* is noticed on pages 19 to 21, 32 to 39, and 48 to 54 of that report.

3. The numberless uses to which caoutchouc is applied, the daily-increasing demand, and the very high price paid for it, as well as the total absence of any other product, whether raw or manufactured, that could be used as a substitute, with the sole exception of gutta-percha, which is still more expensive than rubber, had for years attracted the attention of thinking men to this matter, and Mr. Collins's report was therefore welcomed by all, and particularly so by men who took an interest in the development of the resources of India.

4. This report was largely circulated by Government in this country, and the attention of Local Governments was directed to the necessity of protecting the trees which yielded this valuable commodity because it had become quite evident that the caoutchouc trees were being recklessly destroyed in all parts of the world, and particularly so in Assam, which is, so to speak, the only province in India where caoutchouc trees grow, and the experimental cultivation of the indigenous rubber tree *(Ficus elastica)* was accordingly ordered in May 1873 by his Honor the Lieutenant-Governor of Bengal. But by the time these orders reached the Commissioner of Assam, the season was so much advanced, that but little could be done that summer, because there was only one small forest plantation with a resident forest officer in existence at that time, and this was at the Kulsi river, which is not as favourable a locality as the Charduar, in the Darrang district. In the letter district forest work had not had been started, and, consequently, the first commmencement in the present Charduar rubber plantations was not made until the next cold season. A detailed account of these first attempts at planting rubber will be found in paragraphs 80 to 114 of the Assam Forest Report for 1873-74

5. A particular impetus was given to this work by the complications and difficulties that had arisen at about the same time in the proper management of and control over the Indiarubber trade in this province, brought on by

competing speculators, which had necessitated an order from the Supreme Government that the operations of the Forest Department should be limited to conservancy and reproduction of the rubber trees in certain well-defined areas, and to the collection and manipulation of the produce in such limited areas through their own agency.

6. This order of the Government of India was repeated in 1876, and has been acted up to until now: all work in the way of rubber plantations is based on it, and what is more, the experience gained in the twelve years that have elapsed since the issue of that order has made it clear that the effectual protection of selected areas, *with naturally grown rubber trees on them* is next to impossible, on account of the localities where these trees grow being, generally speaking, very inaccessible, and the unequal way in which these trees are scattered about in the forests, as it would mean the protection of enormous areas to ensure anything like the present export of rubber from Assam, and this in turn would mean the employment of very large establishments to watch over the forests, because rubber is so very portable, and its removal not necessarily confined to roads or tracks, rivers, and so forth, as is the case with timber, and the cost of such establishments would altogether exceed the advantages arising from the rubber trade. This simply reduces the whole question of permanently keeping up the export of this valuable product from India to making plantations of the tree that yields it.

7. In April 1874 the Government of India called for a special progress report on the caoutchouc plantations in Assam, which was furnished with my letter No. 23A., dated the 27th May 1875, forwarded by order of the Chief Commissioner to the Government of India with letter No. 1,305, dated the 4th June 1875, and subsequently printed and circulated with the Government of India, Department of Revenue, Agricultural and Commerce (Forests), letter No. 22, dated the 31st August 1875. The efforts made up to that time in the way of planting caoutchouc trees in Assam, and all information regarding the yield of caoutchouc trees then available, have been fully stated in that report, so that there is no necessity for repeating it now; the views expressed by me at that time I hold still in all the main points, and the progress made in planting and the results gained have been recorded in the Annual Forest Reports for Assam up to date, as quoted, so that there is no necessity for repeating this either here, beyond pointing out a few of the main orders bearing on the subject, the chief occurrences which have taken place, fresh experiences gained, and changes adopted in the management:—

Report	of	1874-75,	paragraphs	250 256 and 272-306
„	of	1875-76,	„	65 and 68-77.
„	cf	1876-77,	„	83 and 96-110.
„	of	1877-78,	„	106 and 122-131.
„	of	1878-79,	„	111 and 127-136.
„	of	1879-80,	„	125-127 and 146-151.
„	of	1880-81,	„	113-118 and 137-145.
„	of	1881-82,	„	110-115 and 136-142.
„	of	1882-83,	„	77-78 and 83-85.

8. The Charduar plantation has, as was maintained from the commencement, proved in every respect the best locality in Assam where the rubber tree has been planted. The land it is true, is not high, and so we must, no doubt, have some area planted on higher ground, if for no other reason than to enable us to make comparisons. This is to be done at once on the high land immediately to the west of the present plantation, as the Chief Commissioner has sanctioned an extension of 200 acres. The present area under cultivation is fully stocked, containing 12,511 trees; they have been planted at 25 feet apart in the lines, which latter are 100 feet apart. This is double the number of trees that was planted on an acre at the commencement. The oldest trees are about 30 to 40

feet in height, and a few from 45 to 50 feet, but this cannot be put down as the average growth of *Ficus elastica* in ten years, since half this time, and longer, these plantations were entirely experimental, and everything had to be learned, as, for instanc, the first trees were all raised from cuttings, which mode of propagation has entirely been given up since the trees raised from seed have proved much hardier and faster-growing and as to the planting of rubber seedlings high up in the forks of other trees, this also has almost entirely been given up, because such trees in most instances did not make more than a few leaves in the year, and it would, as a matter of course, be out of the question to plant rubber trees where they would take a century to become large enough for tapping, when such trees can be grown in a different way in one-fourth this time.

9. On the other hand, it has been found that trees planted on small mounds of earth, 3 to 4 feet in height, grow very much better than if they are planted on ordinary level ground, and this plan has therefore also been adopted, although it adds considerably to the cost of making these plantations, but the faster growth of the trees amply compensates for the higher expenditure.

10. The method of planting adopted from the beginning has been to clear lines from east to west through the forest for the young trees a hundred feet apart; the width of the lines is 40 feet, so that a broad strip of forest 60 feet wide is left standing between these lines, to ensure the utmost amount of moisture in the atmosphere for the young rubber trees. At first the lines were only cleared 20 feet broad, but it was found after a few years that these closed up very soon, and thus retarded the growth of the young trees by shutting out the requisite amount of light. However, the widening of the lines also brought about the faster growth of the scrub in them besides that of the rubber trees, and more money, time, and attention has in consequence to be spent, especially in the rainy season, on these plantations than had at first been anticipated; but the greatest and most costly difficulty that had to be overcome was the effectual protection of the rubber trees against deer, which during the first few years constantly bit off the young plants, and, where they were not entirely ruined by this, they were so much injured and retarded in growth that a considerable increase in the expenditure on these plantations had to be incurred on fencing to prevent it. But for the future this expenditure will not be necessary, since it has been found that saplings 10 feet and more in height can be transplanted without difficulty and with perfect success, and if such saplings are tied firmly to stakes, the deer can do little or no damage to them.

11. The efforts made to interplant with timber trees besides the rubber so as to obtain a yield of timber in addition to that of caoutchouc, have up to the present met with but partial success in the Charduar plantation, but there is no reason to doubt that this will soon improve as the officer in charge gains more experience; in the rubber plantation at the Kulsi, in the Kamrup district, this work has been most successful.

12. The total area of the Charduar caoutchouc plantation is now 892 acres, and has cost R64,351, or R72 per acre. This is abnormally high, since much of the work during the first five years had to be done twice over, and sometimes oftener, because the planting of caoutchouc trees was new, and everything had to be learned and found out by experiments, which naturally took some time. But matters have changed in this respect. We know now what we are about, and the officer in charge of this work, Mr. T. J. Campbell, has estimated the cost of the extension which is at present being carried out at R9 per acre, to which another R6 for subsequent cultivation and clearing should be added, bringing the cost, including everything, up to R35 per acre.

13. Besides the experimental nature of the work, to which the cost of R72 per acre of this plantation must to a great extent be attributed, we have also prepared extensive nurseries, covering an area of about 23 acres, and containing

some 184,000 plants of different sizes, which is sufficient to extend the plantation by 200 acres per annum for the next 151 years, or a square mile per annum for the next five years, if desired, and these nurseries have been so planted that, if for special reasons it is considered advisable not to extend the plantation at any particular time, the trees can be kept almost stationary for 15 to 20 years, without becoming less suited for transplanting—a particular advantage enjoyed by *Ficus elastica* in common with other semi-epiphytes as compared with ordinary trees.

14. These extensive nurseries were got up in accordance with the orders of the Chief Commissioner, communicated to me in Mr. Ridsdale's letter No. 63 T., dated the 10th January 1879, to which I replied in my letter No. 133A., dated the 25th January 1879, that I hoped to be in a position to extend the Charduar plantation by one square mile annually in 1881-82 and thereafter. At the same time Mr. Ridsdale's letter quoted above was written, the Inspector-General of Forests visited Assam, and after close inspection of the Charduar plantation declared it a great success. His views on the subject have been recorded in paragraphs 91 to 104 of his report regarding forest administration in Assam. He suggested an annual extension of the Charduar rubber plantation by 200 acres, at an estimated cost of R36 per acre, or about the same as I estimate now the cost of future extensions.

15. Thus far I have given an account of the Charduar rubber plantation as an experimental undertaking only, and shown that it has been a perfect success as far as the growing of the trees is concerned; but it remains to be considered what the financial results of the undertaking are likely to be, since, as I have always held and do now, the financial success of forest management is the only sound basis on which it can be permanently established and maintained. To make an even approximately correct estimate of the probable revenue that may be expected from these plantations, it is first and foremost necessary to know what a rubber tree will yield, and on this point our information is most imperfect. The statement made by rubber collectors are quite unreliable, and the exhausted state of the naturally grown rubber trees has prevented us until last year from making experiments; the result of last year's experimental tapping, as recorded in Appendix IX of last Annual Forest Report (1882-83), interesting as it is, and much as it has increased our knowledge of the yield of caoutchouc from *Ficus elastica*, still leaves us in considerable doubt on the subject, as has been stated in paragraph 118 of that report. However, so much is certain, that a full-growing rubber tree of about 50 years old will yield at the very lowest 5 seers of rubber, if very carefully tapped, and this quantity may be expected about sixteen times, which will be an equally safe estimate for calculating the yield of a rubber tree. To be quite on the safe side, I will only calculate 10 trees per acre, which would give us about 20 maunds of rubber from every acre. This, at the price at which rubber was collected last year, in the Darrang district and sold, and deducting the expenditure incurred on collecting it, would give us a net profit of R54 per maund or R1,080 per acre in 50 years, and if the rubber trees have a longer life, the yield may be reckoned for their remaining years of life at the same, if not at a higher rate.

16. An acre of first-class timber trees would cost about double as much to plant and maintain, at the rate of 60 trees per acre; and taking the value of the trees at R10 each (the present royalty charged), this would give us R600 only, as compared with R1,080 from rubber, and most of the first-class timber trees will require 100 years to reach maturity, or double the time of a rubber tree. This means, in other words, especially if the compound interest on the capital used is taken into consideration, that an acre planted with rubber-trees will give about four times as much revenue as an acre planted with first-class timber trees.

17. It may be, and in fact has been, argued that rubber might be produced artificially, and that thus a fall in the price might be brought about.

I think there is little to be feared in this respect, not more so than timber has to fear from the extended use of iron; and rubber being a raw product, has a great advantage, inasmuch as the artificially produced article would have all the cost of manufacture added to the cost of the raw materials, and I myself have not the slightest fear in this respect. The price of rubber has been very high for many years now, and during this time it is known that efforts have been made to produce artificial rubber, but that they have failed.

18. It now only remains for me to consider the value of *Ficus elastica* as compared with other trees yielding rubber, both as regards quality and quantity, and although it must be admitted that the rubber yielded by our indigenous tree is slightly inferior to that from some other rubber trees, the difference is so little that in my opinion it has nothing to fear in this respect, and as to the quantity yielded by other species we have positively no authentic information to make comparison; but I am very doubtful whether any of them will yield more than *Ficus elastica*, and certainly the difference, if any, could not be so much as to make the cultivation of the latter unadvisable.

19. Of the two exotic rubber trees which have been tried in Assam, viz., *Hevea braziliensis*, the Para rubber, and *Manihot glaziovii*, the Ceara rubber, the former has failed completely, as the climate of Assam is altogether too cold for it, and although the latter tree grows remarkably fast during the first year or two, and seems to thrive very well, its appearance is not at all such as to make me hope that it will do as well as our indigenous trees, much less that it will do better. Nothing positive can be said on this score until experiments with both have been made under careful supervision by a competent and responsible officer.

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—*Indian Agriculturist.*

THE RUBBER TRADE OF THE UNITED KINGDOM AS SHOWN BY OFFICIAL STATISTICS FOR 1883.

During the five years ending with 1883 the total value of the rubber imports and exports (taken together) has steadily augmented. While it was computed at £3,923,175 in 1879, it reached £6,899,584 in 1883. On the whole, this increase may be regarded as satisfactory, though the exports, as we shall presently show, have not been all that could be desired.

In the returns for 1883, the figures representing the importation of "caoutchouc" (in its raw state) claim special attention, and for two reasons. In the first place, they show a considerable increase over those for previous years; in 1879 only 150,601 cwt. of caoutchouc, valued at £1,626,290, were imported; while in 1883 the quantity was 229,101 cwt., valued at £3,652,817. The advance is still more apparent when the totals of 1882, viz., 181,726 cwt., valued at £2,754,692, are taken into account. A second feature in the return for last year is the addition to the list of countries from which rubber has been imported of several States which had not hitherto been specially named, their identity having been lost by their inclusion under the vague and general headings of "Other Countries," "West Coast of Africa (Foreign)," &c.

The returns indicating the importation of "manufactures of caoutchouc" into the United Kingdom are full of meaning and significance. As in previous years, Germany continues to pour her rubber goods into this country in rapidly-increasing quantities, the imports from that country having risen from 747,608 lb., valued at £72,716, in 1882, to 1,310,547 lb., valued at £125,483, in 1883. The total amount of the importation of manufactures of caoutchouc into the United Kingdom last year was 2,073,374 lb., valued at £211,408, as against 798,772 lb., valued at £87,591, in 1879.

Compared with 1882, there is a decrease in the importation of guttapercha, the amount in 1883 being 63,800 cwt., valued at £476,881; in the first-named year it was computed at 72,936 cwt., valued at £539,814. Imports of "manufactures of Guttapercha" from all countries have slightly increased—from 197 cwt., valued at £1,825, in 1882, to 375 cwt., valued at £3,331 in 1883.—*Indiarubber and Guttapercha Journal.*

RUBBER GROVES.

Last year we bought $8,600,000 worth of rubber from Brazil. Next to coffee and sugar, rubber holds third place in Brazilian exports, and is in great demand in this country because of its superior quality. It is being used now in countless ways, and in late years its consumption has doubled, passing in a stride from the rank of a luxury or non-essential to that of a necessity. Since the industry of collecting the sap and preparing the crude rubber for the market is altogether in the hands of barbarous and nomadic Indians, it is not surprising to learn that no attention is paid by them to the future. They follow blindly the old methods, and the wasteful system of half a century ago is obstinately pursued without any effort towards improvement and economy. These besotted people have no thought beyond immediate profit, and in consequence millions of rubber trees have been destroyed and many others abandoned from premature and inordinate tapping. Intelligent Brazilians, who have given the matter some thought, are of the opinion that the industry has but a short time to live, unless the government interferes and introduces economic measures. When care is taken the results are highly satisfactory. It is known that if the trees are not tapped in August and September, when they change their leaves, groves have continued to yield abundantly for thirty years, and are still in good condition. Little or nothing, however, has been done to propagate the trees, and indiscriminate tapping continues as if the supply were inexhaustible. It is painful to rubber dealers to contemplate that there are no indications at present that effective precautions will be adopted to save the valuable rubber groves.—*Independent Journal.*

RUBBER AND ITS USES.

COMMON wooden trunks are rendered waterproof by being covered with gum-elastic materials.

RUBBER ivory and whalebone are particularly suitable for water or spirit levels, on account of their solidity and their not being liable to warp or crack.

LEVELLING rods when moulded of rubber may be made hollow and light and without a tendency to warp or spring as when made of wood. Like scales and rules, they are graduated in moulds when vulcanised.

SUPERIOR dressing boxes may be cheaply manufactured of rubber ivory instead of fine wood, and when desired can be made with a soft surface of artificial gum-elastic upon the ivory to make them resemble such as have been commonly covered with morocco.

BATHING and flesh gloves are made of knit goods or elastic compound with a sheet of elastic tufted sponge cemented to the face of the glove. They answer the ordinary purposes of a flesh brush, and are made superior to bristle brushes for bathing, as they are not softened by being saturated with water.

GUM-ELASTIC vellum and tissue are cheap and durable materials for the manufacture of banners and flags, not being liable to damage from wet. Fringes and tassels for them may be made of gum-elastic cord spun and twisted while the gum is soft, with the same facility as common thread.

RUBBER ivory has long been recognised as well adapted to the manufacture of the cases of musical boxes, because of its elasticity and durable properties, and the facility with which it is moulded and ornamented.

Expansive cork is made of gum-elastic compound with a screw of metal or rubber whalebone passing through it. Turning the screw compresses or enlarges the cork and makes it fast. Reversing the screw allows it to be drawn.—*Indiarubber and Guttapercha Journal.*

RAW INDIARUBBER: ITS COLLECTION AND PREPARATION.

No. I.—Para.

BY THOMAS T. P. BRUCE WARREN.

A few years ago I was engaged as an electrician in laying a submarine telegraph cable between Pernambuco and Para. After the cable was laid I was stationed at Para for a few weeks, during which time I availed myself of every opportunity for seeing what was to be seen, so long as it did not interfere with my duties or inclination to be idle. It is no use disguising the fact that at midday within a few miles of the equator even an active Englishman is likely to seek the cool retreat of a hammock, in preference to any form of outdoor amusement. Bates, in his "Voyage on the Amazons," says that the Brazilians have a proverb that only Englishmen and dogs are to be found in the streets in the day, so that, at any rate in the eye of a Brazilian, it is no great sin to shirk one's work a little.

During our stay at Para we found the acquaintance of many Brazilians, Americans, and Englishmen, so that at no time had we any reason for being particularly dull or feel our time hanging heavily on our hands. To Captain Bloem, a gentleman in the service of the Amazon Steam Navigation Company, we were particularly indebted for several interesting little trips into the forests. In these excursions Captain Talisman, a gentleman belonging to the same Company, and formerly of the Brazilian navy, acted as pilot. This same gentleman accompanied Professor Agassiz in his journey through Brazil, and was consequently well able to point out and explain to us the marvels around us. I have frequently thought that the immensity and grandeur of these forests would tempt almost any weak-minded man to go off into poetry. We were bent on sterner things, amongst them being monkey-shooting, botanizing, and curiosity-hunting. A strange sensation creeps over one when quietly walking along in these forests; snakes of the most formidable kind may be lurking about ready to pounce upon one, whilst ants, mosquitos, and other small insects are not very particular, if you interfere with them, of illustrating in a practical way their objection to being studied. Then, too, one perspires so freely that one's garments become so saturated as to make locomotion uncomfortable. After two or three visits to the forests one appears to get hardened against strange and poetical fancies.

I have met with no description of these forests which adequately represents a picture of what they really are. The vegetation is no doubt superlatively wild; the mingled chorus of the birds and monkeys, although in striking harmony with the vegetation, would lead you to believe that you were near the Antipodes to Paradise. The crowded state of the vegetation keeps the trees pretty much on a par as regards girth; the wrangling for survival is probably kept under by the richness of the soil. I had no opportunity of seeing Indiarubber trees in their native wildness. These trees are valuable on an estate, and the ground is kept cleared for some distance from the butt; this gives them a chance of developing into good-sized trees. I am not aware of any account being published of the amount of rubber produced by these trees under different ages; this fact, however, is certain, that the owners of these trees will not tap them until they have attained a good size, which will of course depend on the facilities given for their development. An owner has no interest in weakening his plants by drawing too freely at one time. The incisions, instead of being carried around the tree, are more frequently made at intervals on the stem, one above the other,

in a zigzag fashion. Little cups made of clay, and dried in the sun, are cemented to the tree with a little soft clay, directly under one of these incisions, so that the sap flows freely into them.

I have frequently noticed the exaggerated ideas which are evidently current with regard to the collecting of the sap. Only a short time ago I saw an illustration in which the sap is represented as gushing out in a perfect torrent. At different periods of the year the sap has different degrees of inspissation flowing more copiously when the elaboration of sap is most active, and becoming slower as evaporation from the plant and dryness of the season set in. These conditions would indicate the necessity for repose, and growers who have an interest in their plants act accordingly. It must not, however, be supposed that to tap a tree at this time involves any serious peril, for the sap flows very slowly, and in a day or so heals up. When sufficient sap or juice is collected it is poured into a large earthenware pan, and the liquid is dried in successive layers on a mould formed of clay, until the desired thickness is obtained, or until the juice is all used up.

The mould is thus made:—A piece of wood of a convenient length for a handle, about one inch or more in diameter, is coated with a layer of clay about 6 or 8 inches long, and from 3 to 5 inches diameter tapering at top and bottom. After drying in the sun it is ready for use. The clay-covered part of the handle is dipped into the juice and moved about so as to facilitate the removal of adherent air-bubbles, and then lifted out, and the handle carefully turned round and round, so as to keep an even thickness or coating all round. When this coating is set, another dip is made the additional coating dried, and the operation repeated for as many coatings as may be necessary. When finished the whole is held over a fire made by burning the nuts of the Urucari palm fruit until it becomes of a dark rich brown colour. In the state it rapidly darkens. It is becoming more and more rare to find this smoked Para rubber; this may be due to the scarcity of the palm nuts and the want of a suitable substitute.

Whatever may be exhalations from the roasting nuts it is evident that the Para rubber so treated may be kept for years without deteriorating. At one time, each coating was dried or coagulated by the heat from these fires. The statements made by some writers on this smoking process are absolutely ludicrous, and suggest the acceptance second-hand of a description which has been borrowed from a writer who has embellished a description by someone else, and which was probably correct until it received the adornment. The peculiar cooked-like odour of the Para rubber is due to the oil which rises from the burning nuts, and the curious-shaped nuts sometimes found in packages of Para or Negrohead rubber are those which are used in this smoking.

It may be a troublesome thing to prepare Indiarubber in a climate like India, so as to ship it in a condition likely to compete favourably with the rubbers from Brazil and elsewhere, and I would therefore suggest that it may be worth while to try the effect of smoking the prepared masses of Indiarubber directly they are finished. At any rate, the danger from handling might be avoided, as Indiarubber in contact with perspiration soon becomes soft and sticky. After the bottle is finished it is cut open by a longitudinal slit, so as to remove the mould; the clay is broken up, and the handle drawn through the neck ot the bottles. It is then placed under pressure, when it takes the form of the well-known Para bottle-rubber. It is a very common thing to find a small hole through the flattened bottles. These holes are made so as to string them together in piles, in which form they are sent by the collectors to Para or to the merchants.

Bates says that the thongs used in threading up the bottle is an air root of an epiphytous plant. On our visits to the forests just outside Para we saw an immense number of these thong-like roots hanging down from the highest branches of the tallest trees, and reaching to the ground. One of our party hung on to one of them without its breaking. I do not remember seeing any

of these thongs in a package of Indiarubber. The strength of these thongs must be very great, as one about a quarter of an inch in diameter is quite sufficient to support about one hundred and fifty pounds of rubber.

The rubber thus prepared is conveyed by canoes to the ports from which it is exported. The merchants who ship the article obtain it from the natives in exchange or barter for other commodities. The rubber accumulates in the warehouses of these merchants until sufficient is collected to make a consignment to a shipper or broker, whence it find its way in this country to the ports of Liverpool and London. This rubber is eagerly sought after by the Americans, and there is no doubt that its price is kept up by competition between the English and American markets. A great deal of rubber is now shipped direct from Maranham which was formerly sent to Para. The purity of this rubber commands for it a good price.—*Indiarubber and Guttapercha Journal.*

RUBBER NOTES FROM BRITISH AND AMERICAN CONSULAR REPORTS.

ZANZIBAR.—A volume of British Consular Reports, presented to Parliament in May, 1885, with which we were unable to deal last month, owing to pressure of space, contains an interesting communication on the subject of native African guttapercha, sent in December, 1883, by Sir John Kirk, our Consul at Zanzibar, to Earl Granville, the late Secretary of State for Foreign Affairs. This report was accompanied by a sample of guttapercha, the produce of a practically unknown tree, which Sir John found at Mombasa. It appears that several samples of this article had been brought to Mombasa from time to time, and offered for sale by the natives; they had, however, been set aside as useless, and regarded as an adulteration of Indiarubber until the Consul detected their nature, and indicated the great demand likely to arise, provided it could be had to any great extent. Sir John Kirk, in his despatch, stated that he was not aware that guttapercha had hitherto been discovered in Africa, and in view of the importance of the matter he requested Lord Granville to send a sample of the guttapercha to the Director of the Royal Gardens at Kew, with a view to a technical opinion being given with regard to its probable value and quality, remarking further, that it was not ten years since he "established Indiarubber collection from plants growing wild on the mainland, the value of which amounted last year (1882) to £300,000, and the plants which yield this are now being grown in India and all our tropical colonies." In a supplementary despatch Sir John reports the success which has attended the planting of rubber trees in Zanzibar. He says:—"Five years ago I received from the Director of the Royal Gardens, Kew, in exchange for plants of our African Indiarubbers of the genus *Landolphia*, other sorts of Indiarubber giving plants, amongst which were the Para tree, or *Manihot Glaziovii*. This, I find, grows here with the greatest rapidity, and propagates itself freely in the worst soil. It is only now, however, that I have been able to obtain a sample of the Indiarubber likely to be produced, and on which the value of the new introduction entirely depends. I find that trees only begin to yield when five years old, and no doubt these are, even then, too small to be remunerative. I have collected a sample of the produce, which I forward by this mail, and which I would ask your lordship to be good enough to forward to Sir Joseph Hooker, at Kew, to be reported on. If the quality of this Indiarubber is found to be good, I can then confidently encourage the Sultan to plant widely the new tree in the unoccupied parts of the island. It stands the climate, grows freely, needs no care, and would be a source of income on which his people might fall back in the event of other crops failing." In compliance with the wishes of Sir John Kirk, the samples were sent to Sir Joseph Hooker, who

placed them in the hands of Mr. S. W. Silver, F. L. S. The latter, besides studying the samples himself, consulted other experts, and the results of the examination may be briefly stated. First as regards the guttapercha, there is a general opinion that the kind discovered in Zanzibar will prove an acceptable addition to present supplies. Sir Joseph Hooker considers that the discovery of a substance resembling guttapercha in Central Africa is of extraordinary interest, though the authorities at Kew were not unprepared for it, the floras of tropical Africa and of Malaya being so similar "that guttapercha-producing trees, which are so characteristic of the latter, might be confidently expected to be represented in the former. The rubber-producing vines of each area are, though distinct, so closely allied, and, indeed, mutually representative, and the possibility of the same fact should be borne in mind in connection with guttapercha." Mr. J. V. Bailey, of the Indiarubber, Guttapercha, and Telegraph Works (Limited), writing to Mr. Silver with respect to the samples sent by Sir John Kirk remarked: "The sample of guttapercha is not so good a specimen as we get from other parts of the world; nevertheless, in its present state, we may put the value at about 10d. per lb." Secondly, as regards the specimens of Indiarubber from Zanzibar, it is pointed out that there is some discrepancy, as Sir John Kirk appears to have mixed up two distinct plants. It is tolerably clear, however, to the experts that what he has sent is Ceara rubber, and not that of Para, and that the plant producing this is cultivable with such ease, that it is much to be hoped that it may form the basis of a new and profitable industry in the Zanzibar dominions. Referring to these samples of Indiarubber, Mr. Bailey says: "Indiarubber collected from the trunks of the tree would be at the present time commercially worth about 1s. 9d. to 2s. per lb. The sample collected from the ground we could put no value to." The action taken by Sir John Kirk might be imitated with advantage by British Consuls in other parts of the world where there is any possibility of Indiarubber or guttapercha being produced.—*Indiarubber and Guttapercha Journal.*

RUBBER TREES IN CEARA.

The following information has been received from Mr. George Holdern. the acting British Vice-Consul at Ceara, in reply to questions sent out by the authority of the British Government, with reference to cultivation of the Indiarubber tree in that province:—

Query—What are the names and productive qualities of the different kinds of rubber trees grown within your district?

Answer.—There are two kinds of rubber trees known in this province: first, the "Manicoba" plant from which the Sernamby rubber is extracted, and secondly, the "Mangabeira" from which, with the application of alum, the "Mangabeira" rubber is produced.

Q.—What is the extent of land under cultivation by said trees?

A.—The Manicoba trees are only cultivated to a very small extent on the mountains of the "Serra Grande" and Serra da Uruburitama, the greater part of the trees growing wild are over the mountains, at an estimated area of 20 leagues. On the Serras of Maranguape and Pacatuba many trees are to be found, but in this district they have not been cultivated. The Mangabeira tree grows wild in nearly every wooded district where there is a sandy soil.

Q.—What is the nature of the soil most favourable for the cultivation of the Indiarubber tree?

A.—The soil most suitable for the cultivation of the "Manicoba" plant is the clay soil of the mountains. For the "Mangabeira" the sandy soil of the low lands, especially towards the coast. The planting of the "Manicoba" is very simple either from the seeds or from slips of trees. The cultivation of this plant has not been much extended in this province, the people limiting

their efforts to substituting any tree that many die by another from seeds or slips. Most of the planting has been done by nature; every year when the Manicoba fruit or seed is ripe it drops off the tree, and falling into suitable ground springs up without any care whatever being given to it.—*Indiarubber and Guttapercha Journal.*

RUBBER IN CEYLON: THE IMPROVED SYSTEM OF GATHERING MILK—SHOULD HARVESTING BEGIN?

London, E.C., Dec. 2nd, 1885.

DEAR SIR,—I have read the letter Messrs. Marvál Irmãos have addressed to you. I am aware of the nature of their process and can fully confirm what they say. I cannot agree with your remarks when you say that Ceylon has not sufficiently advanced in rubber culture, because you have the Cryptostegia grandiflora and other rubbers which yield milk and they are quite amenable to this process which is both simple and inexpensive. Dr Trimen will confirm the fact of my having sent him some years since Mangabeira rubber seed, telling him at the same time that it produced a very fine rubber.—I am, dear sir, yours truly, THOS. CHRISTY.

COLLECTION AND PREPARATION OF GUTTAPERCHA.

The collection of guttapercha generally takes place directly the rainy season is over, as in the dry season the gutta does not flow so readily, and during the rainy season the collectors are more liable to attacks of ague and jungle fever, and often after cutting down a tree a heavy rain will wash away the gutta as it flows out. At times the collectors go in companies, often receiving advances in money, clothes, food, and tools, to be afterwards deducted from the proceeds of their expedition, although cases are not unknown where the trader who makes the advances loses principal and interest from the non-success, death, or knavery of the collectors. Sometimes the natives who live in the vicinity of the trees collect the gutta and exchange it at the trading stations for goods of which they are in want. There is a curious belief amongst the natives that if a tree be cut down at the time of the full moon, the result is better than at any other time, as the juice flows more readily, although, on the other hand, other natives affirm that the seasons make little or no difference.

Yield.—The yield of a well-grown tree of the first or best variety is from 2 to 3 lb. of guttapercha, such a tree being about 30 years old, 30 to 40 feet high, and 30 inches to 3 feet in circumference. A full-grown tree sometimes measures 100 to 140 feet to its first branches, and with a girth of 20 feet at a distance of 14 feet from the base. Such a tree will sometimes yield 50 to 60 lb. of guttapercha, which quantity loses about 35 per cent of its weight in six months from drying. There is also a great difference in the relative yield of different varieties, sometimes amounting to 20 per cent.

Method of Extracting.—Guttapercha is extracted in much the same way amongst Malays, Chinese and Dyaks. The trees are cut down just above the buttresses or banees, as they are called; and for this purpose a staging about 14 to 16 feet high is erected. The tools used in felling are either "beliongs" or "parangs." A "beliong" is a chisel-like axe, used by the Malays in cutting down trees, building houses, &c. The blade, as will be seen, is of a chisel-like form, and is secured to the handle by a lashing of "ratan" or cane. The Chinese often use an axe perfectly wedge-shaped. The "parang" with its short sword-like blade, is used to cut the rings round the trunk; it is a box of tools in itself in the hands of a good Malay, as with it he can cut up his food fell a tree, or building a house. They are made of various sizes, the one

figured was given me as a keepsake by a Hadji from Palembang, on his way to Mecca, and is drawn quarter size. All these tools are forged by the natives themselves, and are used with considerable dexterity.

As soon as the tree is felled, the greatest haste is made to lop off all the branches, the natives asserting that if this is not done all the gutta would ascend to the leaves. Captain Lingard relates one instance where, it being late in the evening, one tree was left with the branches on, and the result was that in the morning, instead of obtaining 40 to 60 lb. of gutta only 10 lb. was obtained. The next operation is to cut and remove narrow strips of bark about 1 in. broad and about 6 in. apart. These cuts do not extend all round the tree, the under part of the tree being buried in the soft earth as it falls, and thus much gutta is wasted. Some natives also strike the bark with mallets, in order to accelerate the flow of milk. The milk or gutta flows slowly (changing colour as it flows) and rapidly concretes, and is of a different colour in different varieties, varying from a yellowish white to a reddish or even brownish tinge. The gutta, as it flows, is received in hollow bamboos, doubled-up leaves, spathes of palms, pieces of bark, coconut shells, or even in holes scraped in the ground. Only two-thirds of the gutta is thus extracted, as one-third is buried in the ground. Captain Lingard told me that once he induced a native "pungula," or head man, to roll over a tree which had been felled four years, and even than a large quantity was extracted. If the quantity collected is small, it is prepared on the spot by pressing it together in the hands into a mass, and making a hole in the one end of the mass and passing a ratan through to carry it by. Often it is sent into the market in this state, and is then known as "raw gutta" or "getah muntah," the latter word in Malay meaning "raw." If water gets into the juice, the gutta becomes stringy and is considered deteriorated, but after being boiled appears quite as good. Sometimes the gutta is kept in raw state for a month or two, and then undergoes the next step in preparation, that is, of boiling, but this should, I believe, take place *immediately* after collection. The boiling is generally conducted in an iron pan or "kwali." These are cast or stamped pans. 15 inches in diameter and 6 inches deep, with two handles rivetted on. Those made in Siam are generally preferred. The boiling is either made with simple water or with the addition of lime-fruit juice, salt, or coconut oil. Lime-fruit juice and salt are added to hasten coagulation. If one point of the former be added to three gallons of gutta milk, the gutta coagulates or coagulates immediately on ebullition. and this addition expedites the preparation very materially. Coconut oil is added to give a better appearance to the product.

When the gutta arrives at the port of shipment, before it is exported it generally undergoes an examination with a view to classification in suitable classes. As it is received it presents great diversities as to appearance, shape, size, and colour; from crumling, hardly coherent, whitish or greyish "raw" or getah muntah fragments, to reddish or brownish blocks as hard as wood. Sometimes it is made up into all manner of grotesque shapes, and nearly always adulterated with sago, flour, sawdust, bark, clay, stones, &c. The Chinese are great adepts in assorting and classifying gutta, and frequently "reboil" the guttapercha by making small parcels of different varieties up to a certain "standard sample." This is done by cutting or chopping the gutta into thin slices and boiling with water in large, shallow iron pans, keeping the contents constantly stirred with poles, and adding good gutta and even coconut oil to give gutta a better appearance. When sufficiently boiled, the gutta is taken out of the pans, pressed into large moulds, and packed for shipment.—*Indiarubber and Guttapercha Journal.*

NEW PROCESS OF PREPARING RUBBER: "MANGABEIRA" RUBBER SUITED TO CEYLON.

BAHIA, 16th August 1885.

GENTLEMEN,—We have perused with a great deal of pleasure your valuable book on "Indiarubber," and seeing that you are much interested in the "article," we wish to inform you that we are the owners of a new process of preparing rubber direct from the milk doing away entirely with the tedious method of evaporating or smoking. We can at a trifling cost and in a few hours convert into marketable rubber any amount of milk, producing a rubber equal, we say even superior, to the finest Pará, out of the "Mangabeira" milk, which is the rubber-tree we have here in abundance, but, unfortunately, all the trees have been so badly cut by the natives that they do not yield any milk at present, whilst, if properly bled, they should give milk every month. We enclose a sample of *Mangabeira rubber* made by our process. As you will notice, it is perfectly dry and differs totally from the spongy stuff known as commercial Mangabeira rubber. We came here a short time ago hoping to get large quantities of milk, as we had been informed that there are here immense tracts of trees, which is true, but we were not aware that they had been so badly damaged. We shall therefore have to move very far into the interior where there are still thousands of trees intact, before we can apply our process on a large scale. e had some thoughts of goi ng up the Amazon, but health considerations have deterred from doing so, one of us here having already being carried away by yellow fever. We should be very glad to make an arrangement with some of your planters to sell them our process for Ceylon; if there is sufficient interest evinced, one of us might go out to Colombo to demonstrate by *facts* the value of the invention. We should state that samples have been submitted to manufacturers in Europe and America, and after trial declared to be excellent and applicable to all the different requirements of the rubber manufacture.

Mangabeira.—As your book contains very little information about this tree, it may interest you to know that the plateau on which it grows is not 4,000 or 5,000 ft. above the level of the sea, but only about 500 or 600 ft. It grows *only*, in sandy soil, and where it grows there are only one or two other trees to be seen.

MARVAL IRMAOS.

[We are obliged to our correspondents for this interesting letter. Ceylon is rather too young as yet, as a rubber-producing country, to make much of the patent process, although we shall be glad to put any of our readers interested, in communication with the writer of the above. The sample of rubber, vastly superior to anything as yet gathered in Ceylon, can be seen at our office. We should be glad certainly to see "Mangabeira" rubber introduced, and, if our correspondents send us some seed, they will confer an obligation. —ED.]

THE INDIARUBBER GATHERERS OF THE AMAZON.

For the most part the juice of the seringa has been hitherto collected on the islands and swampy portions of the mainland which lie within a distance of a hundred miles of the port of Para, and for that reason the produce is known as Para Indiarubber. In the great delta, away from the channels that have now become the highway for steamers between Para and the main Amazon, the explorer may paddle about in his palm-decked canoe through hundreds of miles of sequestered creeks, lakes, and streams, under the shade of huge overhanging trees of the richest vatiety and luxuriance, and for weeks together he will not find the slightest trace of man's existence in the dense solitudes, but here and there the hut of an Indiarubber gatherer. Although the industry

is largely confined to this limited district, the tree flourishes with equal vigor in all the swampy districts bordering the Amazon, and there are groves of untapped, serinagas growing by the Tapajos, Maderia, and other vast tributaries of the central river. Indeed, the traveller by the steamboats (of English make, by the way) that ply on the Amazon from Tabatinga—the first fortress in Brazil on the Peruvian border—to Para, which is quite two thousand miles distant will observe that Indiarubber is an article of export from nearly all the places at which the vessel calls. At the remote Tabatinga itself, rubber and salt fish are taken on board, the contributions to the civilised world from the numerous Indians who dwell in the adjacent forest. Five hundred miles further down the river stands Ega, on the tributary Teffe, half-way across the continent. Bates, who lived there exploring to the interest of science for four years and a half (Agassiz fished there for six months), exclaims, "What a future is in store for the sleepy little village!" At present, that distant population of 1,200 composed of pure Indians, half-castes, negroes, mulattoes, and whites, exports Indiarubber along with cacao, sarsaparilla, Brazil nuts, copaiba balsam, salt fish, turtle oil, and other products of the district. At Manaos, a thousand miles from Para, there is "enough Indiarubber to coat the civilised world." The same article—although cacao is the favourite product from this point—is taken on board at the mud village of Villa Nova, and so also at the town of Santarem, to which it is brought down from the river Tapajos. Still, as we have said, the greatest portion of the supply is obtained in the swampy districts nearer Para and the mouth of the Amazon.

The caoutchouc-gatherer reaches the swampy regions on which alone the Para rubber tree grows towards the close of August, when the floods that have prevailed for four months and kept the trees under water to their crowns, have gone down. A spot is chosen where a good supply of rubber trees is at hand, and in selecting it the gatherer has to take care that too dense an undergrowth does not hinder a ready passage between the hut and the trees. The caution is highly necessary, for the juice is rapidly spoiled by contact with the air, and every one must be familiar with the difficulty of threading a Brazilian forest because of its marvellous mazes of creepers and shrubs.

A piece of ground, of a size proportioned to the number of the household or group, is cleared leisurely, about a yard of the stumps being left standing. At intervals the mestizo, with a genius for saving himself trouble, allows some of the harder trees to remain, in order to serve as supports for the roof. The floor of the projected dwelling must be raised above the reach of the water, and accordingly the felled trees are placed upon the stumps for that purpose. Small strips of the bark of the muruti palm are laid down as flooring. To form the framework of the roof thin trunks are fixed to the stems that have been left standing, and over this are placed immense palm leaves, sheltering a space probably sufficient to accommodate a company of twenty persons. To serve as walls—there is no need in the tropics of any protection against cold—bass-mats are hung all round the structure on a horizontal pole. Partition of the building into apartments is not regarded as an indispensable feature among these semi-savages, and the highest conception of refinement among them is satisfied by the construction of a ladie's chamber in the centre by hanging up a few mats. The staircase is not an invention that requires much toil or genius; some blocks are laid above each other, or a tree stem, with rough steps cut into it, is placed obliquely against the hut floor.

Look now at the pantry. A space at the foot of some neighbouring tree is cleared of earth to a depth of two or three feet and fenced round. The adjacent stream fills the pond with water, and to this reservoir are consigned the fish and turtles that are caught. Less care is bestowed on the food obtained by the Indian's gun; what remains over the necessity of the day is simply dried in the sun, or salted and preserved in well-shaded spots.

The last few days before the caoutchouc harvest actually begins are spent assiduously in increasing the stock of shells and clay vessels necessary for collecting the juice, in gathering a store of tenacious clay for attaching these receiving vessels to the tapped trees, and also in laying in a supply of a certain kind of palm-nuts, which, as we shall see, play an important part in the preparation of the milky juice of the *Hevea Brasiliensis* into the India-rubber of commerce.

The tree, which is the object of so determined an attack from September till January or February, cannot, indeed, be spoken of as at all remarkable in appearance in the giant forests of the Amazon, but it is certainly an imposing tree, often towering to a height of sixty or eighty feet; its round, straight, pale-grey trunk is devoid of branches till far up, as is the habit of all forest trees; the trunk has a circumference of two or three yards, and bears a stately but not widely spreading crown. The foliage is beautiful, the long thin leaves growing in clusters of three, the central one being more than a foot long. The fruit is of about the size of a large peach, and is divided into three lobes, each of which contains a small black nut, not only edible but eagerly sought by the wild animals of the forest. In fine, the bark and foliage of the Para rubber tree have a strong resemblance to those of our own ash.

In the early morning, between the hours of five and six, the mestizo, in his light cotton vest and pantaloons, sets out from the rude hut, bearing with him a small axe, the edge of which is about an inch long. With this he makes twenty incisions or so into the bark of every third seringa at a convenient height, and with a little soft clay sticks one of his small shallow earthen cups just beneath the incision, to receive the milky sap that now oozes out drop by drop. In a few hours he has thus tapped thirty or forty trees with the assistance of his wife and children.

It is now time that he should make a second round, in order to collect the juice; for, although the tiny cups are not yet filled, the wounds are already closed up with dried juice, and the sap itself now requires to be looked after if it is to be a good marketable article. Instead of the hatchet, the seringueiro this time takes with him a small wooden bucket, into which his wife and children empty the contents of the cups, each of these holding, perhaps, half a gill of juice. The emulsion, while still fresh, has an agreeable taste, not unlike that of sweetened cream. The skin of sap that has attached itself to the bark under the incisions, or to the edge of the cups is also stripped off and stuck on the outside of the bucket. The husband clears the wound and sticks on another cup for the second crop of the day. The sap that has been obtained is immediately conveyed to the hut and subjected to the following important process.

A fire of brushwood is kindled, and on this a narrow funnel-shaped pot of clay is placed, in or underneath which the palm nuts already referred to are heated. The seringueiro, with the bucket of juice by his side, seats himself before the fire, dips a club-shaped piece of wood with a flattened clay mould at one end into the milk, and turns the juicy end round and round in the white vapour issuing from the pot. In half-a-minute the milk is changed into a skin of a reddish tint. When this is firm the stick is again dipped into the milk; and so the process goes on, layer being added to layer, until a sufficient thickness has been obtained. Another stick is then taken up, and the work goes on until the juice has been exhausted. The benefit of the nut smoke is alleged to consist in its absorption of the oxidised resin of the juice, and it is the smallness of the quantity of this resinous body in Para rubber that gives it the highest value in the market of the world. A good hand will make five or six pounds in an hour. When the cakes are completed they are slit up with a sharp, wetted knife, and after being hung in the open air to

dry for a few days, they are ready for sale. The flat, rounded Para rubber cakes, made in the way we have described, are known in London as "biscuits," and command a higher price than any other kind of caoutchouc.

On the same day the trees are exhausted once more, and even twice, if they are rich in milk—a quality that reaches its maximum when they are about twenty-five years old. On the second day the second portion of the tree is attacked and dealt with; the third portion on the third day; and on the fourth the first portion may again be tapped with impunity.

How does the gatherer secure the sale of his caoutchouc? Boats ply up the rivers and creeks during the season with wine, trinkets of all sorts, and an endless variety of wares, and the rubber is exchanged for these articles. The chief delight of the half-savage Indian is in procuring fireworks, and days of toil are sacrificed for one evening of festive illumination.—(Abridged from *The Welcome.*)—*Indiarubber and Guttapercha Journal.*

MANGABEIRA RUBBER.

This rubber is likely to attract considerable notice in consequence of a recent favourable development in the manipulation of the raw material. When first imported, owing to the careless way in which it was collected and prepared, it only fetched about sixpence a pound. But it has recently been imported by a Brazilian merchant in very fine condition, and the article when submitted to some of the best London firms, has been declared to be worth three and four-pence a pound. The rubber is especially suited for springs of railway and tram cars, and for similar purposes.

Through the kindness of Messrs. Christy, we are enabled to present our readers with some information concerning this rubber, as well as with a picture of the plant from which it is produced. The Mangabiba, Mangaba, or Mangabeira Tree, as it is called in Brazil, is a small tree belonging to the *Apocynaceæ* —with an elegant mode of growth, like a weeping birch, having drooping branches and small oblong leaves, sharp at the base, but with a short rounded point at the apex. The tree yields an excellent rubber, but is more frequently grown for its fruit, which has most delicious taste, and is a great favourite with the Brazilians. It is about the size of a plum, of a yellow colour, and marked with red spots or streaks. It is only fit to eat when perfectly ripe, or after being kept for a short time. Hence the tree has the double advantage of bearing fruit which will bear exportation, and of yielding a valuable rubber. The tree is now attracting attention in its native country, having been undeservedly neglected, as may be seen from the following note, taken from the *Journal of the Society of Arts*, June 4th, 1880, p. 631:—

"The inhabitants of Pernambuco are beginning to realize the vast stores of undeveloped wealth existing in their virgin forests, and rubber is being exported from that Province, which may soon rival Parà in the extent of its exports of the article. Recently Senhor Josè Fernandez Lopes issued a circular, April 20th, 1880, calling attention to this important source of wealth, and giving practical instructions for the collection and preparation of the rubber, from which the following is extracted:—'The process of extracting the milk from the Mangabeira is very simple and easy. Each person must be supplied with fifty or more small tin basins and a small axe. He should make oblique cuts sloping downwards at a little distance from each other, all round the trunk of the Mangabeira, cutting only the bark, and placing immediately below each cut one of the basins, securing these either with adhesive clay or nails. These small basins will collect the milk that exudes from the cuts, and when full they must be emptied into larger vessels. This process should be continued during the whole day, and thus three or four bottles of milk may be collected, according to the fertility of the trees. The cuts should not be deep

and a great number of incisions should not be made on each tree, as these may weaken or kill the trees, which has been the case in some instances with the Seringueira, the tree from which the Parà rubber is obtained.'

"The rubber is prepared from the juice as follows:—Put a little powdered alum into a teacupful of water, mixing it well, then put a few spoonsful of this solution into a vessel in which three bottles of the milk have been placed, properly strained to clear it from any extraneous matter. Immediately the milk coagulates, which will be in two or three minutes, the rubber must be exposed to the air on sticks, and allowed to drain for eight days. After thirty days it is ready to send to market in cases or barrels."

To the above it may be added that in incising the trees it would be better to use a guarded axe, *i.e.*, one thickened in the upper part of the blade to prevent its penetrating the bark beyond a certain distance, so as not to injure the cambium or juicy layer, for if this be pierced the tree is likely to decay.

The use of alum or salt, or any such substance, to coagulate the rubber, is liable to render it wet and spongy, unless it be prepared in sheets and subjected to strong pressure. The best plan is to evaporate the milk in thin layers, over smoke (as is done in Parà), or in shallow pans in a current of hot air.—*Indiarubber and Guttapercha Journal.*

NOTES ON THE VARIETIES OF GUTTAPERCHA.

BY JAMES COLLINS.

In a previous article* I reserved a more complete enumeration of the varieties of guttapercha for a future occasion. In the present instance, I only give those which I have been able to examine personally; other lists which I have by me require yet further examination and comparison, and fuller materials than at present at my command. Many, too, of these names may prove synonymous, and the really valuable varieties may prove to be but few in number.

1. *Dichopsis gutta.*—Bentley and Trimen's "Medicinal Plants," plate 167. Synonym—*Isonandra gutta*, Hooker, "London Journal of Botany," vi. 463, t. 16, &c. Vernacular names—Gutta Tabán: Guttapercha; Gutta Niato (Sarawak); Guttapercha Durian (Sumatra); Nyatoe Balam, or Balam Timbaga (Bleekrode); Gutta Balam Durian (Borneo); Dadauw (Banka); Mazerwood tree (English). Geographical distribution—Formerly in Singapore in abundance, but only one or two preserved as curiosities; Malacca and Malay Peninsula, as far north as Perak; Sumatra, Borneo and other adjacent islands. In Helfer's collection of Andaman and Tenasserim plants at Kew, there is a specimen of this plant. Remarks—Gutta, or as it is variously written, gutah, gatta, gitta, gatta, is the Malayan term for gum or juice; percha (pronounced soft as in peach, not hard as perka) accentuated variously as parcha, pertja, percha, is the name of the tree, hence the term may be translated "gum of the percha tree." Recently, it has been suggested that percha means strips or fragments, so called from the way the gutta hangs from the incised trees, but this seems too far-fetched. The old name of Sumatra was Pulo or Pulau Percha, meaning "Island (Pulau) of the Percha tree." Tuban, taban is also the name of a tree, and according to Logan a new word has been added to the Malay language, viz:—Menaban (Men[t]aban), signifying collected gutta taban. The greater number of Malay nouns admit of conversion into verbs by the addition of a prefix. The tree is often compared to the Durian tree, *Durio zibethinus*, in its general appearance, and I have classed the Dutch varieties of Gutta Durian under it, as both specimens and accounts agree. Whilst in Singapore, I was fortunate enough to procure a fruiting branch, and

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* Jan. 18th, 1884

also to prepare a little gutta from the same identical tree as the specimens from which Sir W. J. Hooker drew up his description were obtained. These specimens are now at Kew.

2. *Dichopsis gutta*, var. *oblongifolia*. Synonym—*Isonandra gutta*, var. *oblongifolia*, De Vriese, Pl. Ned. Bat. Orient; *ib*. De Handel in Getah-Pertja. Leyden, 1856 with coloured figure. Remarks—This variety found in Borneo differs chiefly in having oblong instead of obvate oblong leaves.

3. *Dichopsis Macrophylla*.—Synonym—*Isonandra macrophylla*, De Vriese. Vernacular name—Ngiato putih (white gutta). Remarks—Mr. Motley, who collected a specimen of this at Bangermassing, Borneo, describes it as a large tree, with white and soft wood, and with whitish green flowers. The flowers had so strong an alliaceous smell, that he could hardly support the smell whilst drawing the plant. It yielded a second-rate guttapercha.

4. *Dichopsis Mottleyana*.—Synonym—*Isonandra mottleyana*, De Vriese. Vernacular name—Kotian. Remarks—Mottley, who found this tree also in Borneo, remarks, "A very tall and straight tree, with smooth reddish-grey bark, reddish within, yielding when wounded a copious flow of milky juice, which hardens to a white waxy resin, brittle when old, but readily softened by heat. Wood, reddish-white, wooly in texture, soon decaying in the weather, but good for housework. The gum is said to be used to adulterate the inferior kinds of guttapercha; it is certainly unsaleable alone. From the seed is expressed an oil used for lamps, and when fresh, for cooking. Grows in deep bogs, where its roots are under water for five months in the year."

5. *Dichopsis obovata*.—Synonym—*Bassia obovata*, Griffiths. Remarks—This guttapercha yielding plant is found in the Tenasserim provinces, and in Borneo.

6. *Payena puberula*.—Synonym—*Isonandra puberula*, Miquel. Remarks—Is found in Sumatra, and attains a height of 60 feet to 80 feet.

7. *Payena dasyphylla*—Synonym—*Isonandra dasyphylla*, Miquel, Remarks—Known under the name of Gutta Benton, and is found in Borneo and Sumatra. According to Motley, it yields a second rate gutta, and is chiefly used for purposes of mixing with finer qualities. The tree grows in dry woods, having hard, white, and heavy timber, black, hard, and smooth bark, and abundant foliage.

8. *Payena Wightii*.—Synonyms—*Ceratephorus Wightii*, Hassk.; *Isonandra polyandra*, Wight. Remarks—A Sumatran tree.

9. *Payena Leeri*.—Synonyms—*Ceratephorus Leeri*, Hassk.; *Azaola Leeri*, T. & B. Vernacular names—Balem-tjabeh, Balem tandoek, Koelan, Getah Seundek. Remarks—This tree, found in Palembeng (Sumatra), Java, and Banka, is said to yield a very fair gutta.

10. ? *Payena macrophyllus*.—Synonym—*Cacosmanthus macrophyllus*, Hasskl. Remarks—This tree, known under the names of Karel Mundieng and Getah Pertja, is found in Java, and grows to a height of 60 feet to 70 feet.

11. *Chrysophyllum lanceolatum*, D. C. Synonyms—*C. Javanicum*, Steudel; *Nycteristition lanceolatum*, Blume. Remarks—Known as the Kilakkatang, in Java, and grows to a height of 60 to 80 feet.

12. *Chrysophyllum rhodoneuron*, Hassk.

13. *Sideroxylon nitidum*, Blume, the Kinjatoe of Banka and Njatoe of Banka.

14. *Sideroxylon attenuatum*, D. C., known as the Taroentoong and Binasie, and found in Singapore, Java, Banka, and Phillippines.

15. ? *Sideroxylon chrysophyllum*, De Vriese, found in Java.

16. *Bassia cuneata*, Blume, a tree of 60 to 80 feet high, found in the Bantam district in Java.

17. *Bassia sericea*, [Blume, known as Djengkot in Java.

18. *Bassia argentea*, De Vriese, growing in Java.

19. *Bassia Junghuhniana*, De Vriese, growing in Java.

20. *Mimusops Manilkara*, G. Don, the *Manilkara* of Rheede, and the *Metrosidoros Macassariensis* of Rumphius, growing in Java.

21. *Mimusops acuminata*, Blume, known as Genkot; grows in Sumatra and Java to a height of 80 to 120 feet. Remarks—Nos. 12 to 21 are all said to yield a guttapercha which is more or less utilized; frequently, however, for mixing with better sorts. There are numerous varieties of guttapercha which have come under my notice, to which no botanical position has been assigned. A few of these need only be mentioned here.

22. *Guttapercha Waringen.*—Under this name a Guttapercha is collected on the Kapuas river in Borneo. The tree is described as being like the Warringen tree (*Ficus sp. varia*), with white wood, and grows in the hilly country, and generally in yellow clay soil.

23. *Nettu.*—Found on the south coast of Borneo, and said by Motley to yield a second-class gutta.

24. *Ploot* is found in Borneo, and yields a third rate gutta. The tree grows in hilly districts, and its sap is brownish. The leaves and bark resemble the Champaca (*Michelia Champaca*), but the leaves are redder on the under-side. The name Ploot, or P'loot, is a Dyak term, and the only one they seem to use for guttapercha.

25. *Guttapercha Papua.*—This is a fourth class gutta, and is in less demand than the two preceding ones. The tree is found on low ground in Borneo.

26. *Guttapercha Rana.* This variety, found also in Borneo, is in very little demand, as it is of low quality it is of a white colour when boiled.

27. *Katella.*—Borneo; used only for adulteration.

28. *Jankar*—Same as 27.

30. *Guttapercha Kladi.*—Same as 27.

31. *Guttapercha Daging.*—This comes nearer in character to the Balata of commerce than any other Eastern product I have met with, and should most assuredly receive attention. "Daging" is the Malay term for "flesh," and aptly describes the toughness and gristly character of the generality of beef one meets with in the East.

32. *Gutta Muntah.*—This is unprepared gutta, "Muntah" being the Malay for "raw" or "uncooked." Hence the term is equally applicable, and, indeed, is applied to every variety of unprepared guttapercha. Some years since, this name was known and used in the English market, but now is apparently supplanted by that of "White Borneo." It may be of the best quality of guttapercha, or the very lowest; whichever it may be, if not boiled up quickly, it loses all its value, and becomes a mere resinous mass.

The following names and remarks on varieties of guttapercha were kindly furnished me by Captain Lingard, who, as a trade and rajah, has had many years' experience of the question in the Brow and Boolongan districts on the east coast of Borneo:—

33. *Getah Kalapeieh Lanyut* (Brow).—Lola Lanyut, of Boolongan, is the first and best quality, and is known in the English market as Lingard's "Nina" brand. "Lanyut" means "tough."

34. *Getah Kalapeieh Mookas* (Brow).—Lola Mookas (Boolongan), is a second quality. The tree yields about 10 per cent less than the first quality, and is more difficult to cut down. "Mookas" means "spongy."

35. *Getah Kalapeieh Kapur* (Brow).—Lola Kapur (Boolongan) is a third variety, and yields 10 per cent less than the preceding; in the wet season even 20 per cent less. The wood is much harder, and requires a stronger and heavier billiong to cut the tree down.—*Journal of the Society of Arts.*

INDIARUBBER.

The substance sold under the name of indiarubber is the stiffened milky juice of at least six different genera of trees, belonging to three widely different natural orders—Landolphia and Willughbeia in Apocynaceæ, Castilloa and

Ficus in Artocarpeæ, and Hevea and Manihot in Euphorbiaceæ. Part of it comes from South America (shipped principally from Para and Carthagena), part of it from Sierra Leone, Mozambique, and Madagascar, and the remainder from tropical Asia. Besides these two genera of Apocynaceæ there are at least six others which yield a similar milky juice not at present utilized to any considerable extent. In the United States in 1883 there were 120 indiarubber factories, employing 15,000 hands. The total importation of raw material into the States in that year was 3,000 tons, worth about £6,000,000 sterling. The value of the manufactured goods made in a single year is estimated at £50,000,000. The quantity of unwashed rubber imported into the United Kingdom in 1883 was more than 10,000 tons, worth about £3,500,000, but in 1885 it had sunk to less than £2,000,000. None of the trees which yield india-rubber have yet been brought into cultivation on a large scale, and the time will soon come when either this will have to be done or the supply will gradually lessen. There are about sixty distinct species of these rubber-yielding genera, and the botanists and foresters will have to settle between them which of these are best worth cultivating and where it will pay to grow them. Unfortunately, at the present time the price of indiarubber of all kinds is exceptionally low, the best Para rubber being now only worth about 2*s* 6*d* per pound in London against 4*s*. in 1884, and the best of the African and Asiatic kinds about 2*s*. per pound.

List of the Indiarubber-producing Genera, their native Countries, with the Number of Species in each and Annual import:—

Order.	Genus.	Number of species.	Native country.	Tons imported into England in 1880.
Apocynaceæ ...	Willughbeia	9	Tropical Asia ...	530
,, ...	Landolphia, including vahea	16	Africa and Madagascar ...	2200
,, ...	Hancornia	1	Brazil	—
,, ...	Urceola	7	Malay Peninsula ... and Archipelago	—
				—
,, ...	Dyera	3	Malaya Peninsula ...	—
,, ...	Couma Collophora	4	Guiana and Brazil ...	—
,, ...	Alstonia	3	Malaya and Fiji .	—
,, ...	Cameraria	2	West Indies ...	—
Artocarpaceæ...	Castilloa	3	Central Ameria & Cuba	100
,, ...	Ficus	2	Africa & Tropical Asia	370
Euphorbiaceæ	Hevea	9	Amazon region ...	5768
,, ...	Manihot	1	Brazil	35
		60		7003

GUTTA-PERCHA.—Gutta-Percha of the best quality is the product of Dichopsis Gutta, a tree belonging to the natural order Sapotaceæ, inhabiting the Malayan Peinsula. In order to obtain it the Malays follow the wasteful plan of cutting down the tree. The bark is first stripped off, and the milky juice which then exudes is collected in the shell of a Coconut, or the spathe of a Palm. The juice quickly stiffens on exposure to the air and forms gutta-percha. The average quantity obtained from one tree is 20 lb. In 1875, 10,000,000 lb. in weight were imported into this country from Singapore, and this would involve the destruction of, perhaps, 50,000 trees. It was first brought into notice in 1842, and at that time the tree was plentiful in the forest of the island of Sing-

apore; but during the next five or six years it was totally destroyed in the island except a few trees that were kept as curiosities. In 1847 it was plentiful in the forests of Penang, but a similar fate soon befell it there, and now the time has come when, unless it be systematically cultivated somewhere, the supply will decrease. According to the latest authority there are six distinct species of Dichopsis growing wild in the Malayan peninsula, and in Java and Sumatra, and several species of the neighbouring genera, Chrysophyllum Sideroxylon, Bassia, Mimusops, Payena, and Imbricaria, yield a similar milky juice; but it still remains to be settled which species are best worth cultivating, and where they can be most profitably grown. The annual value of the gutta-percha imported into England is between £300,000 and £500,000 per annum. J. G. BAKER.—*Gardeners' Chronicle.*

ACCLIMATION OF TREES YIELDING INDIARUBBER AND GUTTA-PERCHA.

BY JAMES COLLINS.

The care and oversight of forests is now generally recognised and accepted as a State duty, beyond the limits and capabilities of private individuals. Such duties consist in the protection of trees from reckless destruction, replanting denuded portions, and introducing useful plants from their natural habitats to other localities having isomeric conditions of heat and moisture, and where such introduced plants are likely to prove of general utility. This latter operation is known as acclimation. The constitution of plants is a subject of general inerest, and has to be considered with great judgment and abundance of information; plants have certain limited ranges, and such ranges of heat and moisture have to be clearly defined, for by no process of acclimation can a plant be made to tolerate a degree more or less than its proper limit, except to its detriment. If they be subjected to conditions other than their natural ones, they either die or become so modified as to fail to develop those special features of structure, habit or constituents, which are their characteristics in their native habitat. A single instance may be quoted here, by way of example, to show how a plant may be altered by different climatic influences. In Europe for ages the common hemp (*Cannabis sativa,* L.), has been cultivated for its fibre and oily seeds,* whilst in India the same plant shows a wide dissimilarity, especially in its medicinal characteristics, its leaves, flowering and fruiting stalks yielding a resin volatile oil, known under various names as bhang, dhurrus, ganga, &c., having powerful narcotic properties, the resin being apparently formed at the expense of the fibre, as the stalks are usually burnt as useless.†

The ascertainment of the extremes and mean annual temperature and moisture which best suit certain plants is the result of experiment, and is sometimes surrounded with so much difficulty that frequently trials should be made simultaneously, in two or more localities judged to possess similar climatic conditions.

All these experiments entail expense, especially in the case of those trees the utilisable portion of which consists of timber, milky juices, &c., which require a period of ten, to thirty years or more to elapse after planting before they come to maturity, or any return can be expected on the initial expenditure and upkeep. This outlay, together with the long delayed returns, even if the experiment be finally crowned with success, naturally will and must fail in procuring the accomplishment of such trials by private enterprise. Government must at least give its aid in the initiation of such schemes.

* The great dissimilarity between the European species led Lamarck to consider the latter a distinct one, and designated it *Cannabis Indica*, but it is now agreed that no specific difference exists between them.

† Why burn the stalks of the Indian hemp? Why not utilise them? I have suggested to several planters that they might make capital paper material, especially if sent over here as "half-stuff."

In the case of the cinchonas the Indian Government did, with rare forethought, listen to such men as Pereira, Howard and Markham, and undertook the initiative: and as soon as the experiment proved successful, private planters at once showed their willingness to expend their money in the same undertaking. So has it proved in a minor degree in the present instance.

Another fact is also worthy of remembrance, namely, that acclimated trees invariably improve, and their products, from the care and attention paid in their preparation, acquire a much higher value than spontaneous or uncared-for produce. As instances, mention may be made of the much higher percentage of quinine yielded in India from cultivated trees than from those of South America; and also that a specimen of Assam rubber, prepared according to my suggestions (I think by the late Mr. Leeds) was valued by one of the highest authorities in London, Mr. Edward Till, of the firm of Messrs. Jackson and Till, at from 8d. to 10d. per pound more than ordinary Assam rubber.*

Fortunately, with respect to the special question of guttapercha trees, some of these difficulties do not exist. There, in their natural habitats, and in territory, too, under Imperial rule and influence, are numbers of these trees ready for conservancy and cultivation, and where nurseries of plants can be started for acclimation elsewhere. Although some twenty-five years will have to elapse after planting before the trees are ready for tapping or the axe, yet, in the interim, a revenue could be secured, to pay working expenses at least, from the trees already existing, by "farming" them, or by royalties on the outturn. A stringent rule in all such contracts should be that four to six trees should be planted in place of every one cut down.

As to what species should be cultivated on the spot, or to be introduced, gutta-taban, gutta-durian, gutta-waringan, gutta-kalapeieh, and gutta-mukas stand in the front. Many others, although passing under other designations, may prove equally valuable.

Amongst pseudo guttaperchas, or substitutes recommended as supplementary to the true gutta, I would certainly single out the balata gum (*Mimusops balata*, Gaertner), as it would prove a most valuable addition to our trade supplies. As to the Indian varieties of this group, I would strongly recommend that the panchontee should receive careful attention, and its products collected and prepared in proper manner. Such specimens so prepared would then allow of the question being probably set at rest. I have not much hopes of cattimandoo, mudah, and some other substances. but other uses might be found for them if good samples and guaranteed qualities were available.

As to the climatic conditions necessary for the cultivation of guttapercha trees, Borneo, Labuan, Sarawak, Singapore, and more especially the Southern States of the Malayan Peninsula, being the natural home of these trees, present the first localities in which cultivation should be essayed. Ceylon, like some localities in Assam, and, possibly, the Nicobar Islands, would form a congenial home for these plants.

On the whole question of Indiarubber, gutta percha, and pseudo-gutta, there is much still to be learned. There may be yet many improvements to be made in the collection and preparation, but these facts can only be gleaned by one somewhat conversant with market and manufacturing requirements, added to some amount of botanical and chemical knowledge. Such a task undertaken on the spot, if well executed, would clear up many a doubtful point, and render great and lasting service to commerce and science.—*Journal of the Society of Arts.*

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*In a paper on Indiarubber, delivered at the Society of Arts (*Journal of the Society of Arts*, December 17th, 1869), and again in my report on the same subject to the Indian Government in 1872, I strongly recommended the cultivation of the native *Ficus elastica*, and the acclimation of the *Hevea Brasiliensis*, yielding Para rubber, and also other species from which are obtained valuable commercial varieties. Backed as I was by Mr. Clements R. Markham, C.B., and Mr. Gustav Mann, of the Indian Forest Department, the Indian Government took the matter in hand.

THE AFRICAN RUBBER TREES.

In the West of Africa Indiarubber is collected from several species of *Landolphia*, of which the best known are *L. Owariensis and L. florida.* According to Speke and Grant *L. florida* is stated by the natives to yield the best rubber of any of the species. This plant is a woody climber, growing well in places where little else could be profitably grown, *i.e.*, in damp rocky ravines. Its trunk often travels along the ground, looking like a large boa-constrictor, until it meets with a trunk to climb up. The stem attains a diameter from six to eight inches at a few feet from the ground, and then soon divides into more slender branches, which ascend to the top of the tree, and throw down long pendulous branches and clusters of large snowy-white flowers, scented like Jessamine. The fruit has a sweet acidulous pulp, which is eaten by the natives. The leaves are opposite, and their colourless midribs are sharply angular underneath. Thd young shoots are deep green and spotted, jointed every ten inches, and about one-third of an inch in diameter; they are brittle, and a cord of pith may be pulled out of them. The plant climbs by means of tendrils which arise from the joints, and which consist, in some species—as in *L. Owariensis*—of the hardened flower-stalks after the ripe fruit has fallen off.

The natives make playing balls of the juice of the *L. florida*, and consider its rubber to be the most adhesive known. The milk if rubbed upon the skin adheres like birdlime, and can scarcely be rubbed off.

According to Mr. J. Collins' statement, in the Government Report on the Caoutchouc of Commerce, African rubber is collected and prepared in a very slovenly and wretched manner. The natives cut off a piece of the bark, and the milky juice is allowed to run into holes made in the ground, or on leaves. In some districts the natives simply allow the juice to trickle down their arm, going from tree to tree until the arm is covered, when beginning at the elbow, they roll the caoutchouc back towards the hand, till it comes off in the form of a ring. In other districts the juice is collected and allowed to coalesce in wooden vessels. The wood of the plant contains a gum, so that if cut penetrates beyond the bark, the gum becomes mixed with the caoutchouc and spoils it. Recently, however, the collection has improved in some districts, and the price risen in consequence.

From the above statements it will be seen that the *Landolphia florida* possesses many advantages. Its *flower* might be used for the extraction of a perfume; its stems, from their character, permit the easy extraction of the juice; the plant could be grown on land otherwise useless, while the rubber, if carefully collected, promises to be of considerable value. From its climbing habit and rapid growth it would more speedily attain maturity, and yield a quicker return than the Pará and other rubbers, which are trees, and which could not be safely or profitably tapped under twenty-five years; whereas the *Landolphia* could be tapped when three years old. By the system of growing them in plantations, and cutting down the young shoots almost to the ground every year, the stems and leaves could be taken to the rolling mill, and the crushed mass digested with bisulphide of carbon, in which the rubber is soluble, but which does not dissolve the gum and resinous matter contained in the plant: these if left in the rubber would injure its quality.

The plants could be grown around existing trees, and thus trouble, time and expense might be saved. They are easily cultivated, and, with proper care, are susceptible of much improvement. In cultivation these plants it must be remembered that their chief requirements are a tropical temperature, and a thoroughly moist atmosphere. There is no reason why the *Landolphia florida* should not become a favourite ornament of hothouses in the country, for which its soft green laurel-like leaves and delightfully fragrant handsome flowers especially fit it. In preparing rubber for commerce it should be remembered that large masses of caoutchouc never fetch so high a price in the market as small pieces, for the simple reason that it is much more easy to detect admixtures of dirt and

bark in the small pieces. The more free from foreign substances the rubber is, the higher price it will realise in commerce.

Mr. Collins recommends the preparation of rubber in the form either of separate sheets or cakes, not more than one or two inches thick; and if moulds are used, wooden ones of the shape of a child's battledore, are preferable. Dryness is another important point; if the rubber be prepared by a wet process, such as the addition of alum or salt to the juice, &c., it is necessary to prepare very thin sheets of it, as thick pieces cannot be dried thoroughly. The gradual and cautious application of heat appears to produce the best rubber. Iron or stone vessels are much better for collecting the juice than vessels made of clay, which contaminate the milk and make the rubber of less value. In most of the plants yielding Indiarubber the milk goes to the flowers when the flowering season commences; hence, in gathering the flowers for perfume, there would be the further advantage of increasing the amount of rubber in the leaves by removing the flowers.

Vogel's African Rubber tree, or *Urostigma Vogelwii*, is stated by Mr. Neyle to yield one of the best kinds of Indiarubber in West Africa; it was first collected by Vogel, at Grand Bassa, but was afterwards discovered in Liberia, from whence the first specimens of living plants were sent to Messrs. Christy by Mr. D. J. Dennis.

The tree grows from 20 to 30 feet high, and has large leathery stalked leaves, from 6 to 8 inches long by 3 to 5 inches broad, furnished with four or five lateral veins on either half of the leaf. The small fruits, which are about the size of beans, are found on the terminal leafy branches, usually in pairs, on the stem near the base of the leaf-stalks.

The trees are tapped when about five years old by making slashes or incisions in the trunk, the juice is collected in vessels and the gum is separated from the sap by the use of acids; it is then made up into balls about the size of a large orange. Although the quality is at present remarkably good, it could be geatly improved by care in the collection and preparation for the market. If the trees are tapped before they are five years old the juice is watery, and does not yield such good or strong rubber. The natives, in order to get as large a yield of juice as possible, pollard the trees at a height of 10 to 12 feet and cut back the branches to prevent the strength of the plant being used up in growth; this causes a free and regular flow of sap. The cuttings which are removed are easily propagated and will grow vigorously.

The tree will grow near the sea at an elevation of 50 to 60 feet above sea level, but does not flourish well in marshy ground. The ease with which the plant is propagated, its hardiness in sea air, with the excellent quality ot the rubber which it yields, renders this a desirable species for cultivation in the lowlands of Southern India and Ceylon; also in Java, Sumatra, Penang and Siam.

Amongst other African sources of supply are the *Vaheæ* species found chiefly in Madagascar and the Mauritius. M. Coignet mentions that on the north-east coast of Madagascar caoutchouc is obtained from three varieties of climbing plants, and a shrub sixteen to nineteen feet high. Of the climbers one variety gives the best product, though the natives use all together. The caoutchouc is prepared either with salt water or artificial heat. Madagascar rubber, formerly called Mauritius rubber, has long been largely used in France, and is now highly appreciated in England. In ranks next to Pará in price.

The *Villughbeia edulis*, also found in Madagascar, is a climbing plant which when wounded yields a pure viscid juice, that soon changes to caoutchouc on exposure. This is also an Asiatic plant, and is cultivated in Java.—*Indiarubber and Guttapercha Journal.*

PSEUDO-GUTTA-PERCHAS, OR SUBSTANCES SUPPLEMENTARY TO GUTTA-PERCHA.

From time to time numerous substances have been recommended as substitutes for, or supplementary to guttapercha. That a substance answering these purposes has not yet been introduced lies, I think, more in the fact that these substances have not yet been properly treated, or such a substance has yet to be discovered, than that such substance or substances do not exist. As to the method of preparation of these proposed substances, I have pointed out, in an article on guttapercha,* the rapid oxidation of that substance if it be not prepared immediately after collection. This applies even more strongly to subjects of the present article. Balata gum has an assured value of its own, and with regard to the rest they may yet be utilised if their rapid resinification can be arrested.

In the following remarks but a brief *resume* is given, and the subject geographically treated. In view, too, of the various names which have been given to these plants in various botanical works I also append the synonyms.

I.—AMERICAN SOURCES OF SUPPLY.

(1) BALATA GUM. (2) MIMUSOPS BALATA, GÆRTNER. (3) Natural Order—SAPOTACEÆ.

SYNONYMS.—*Sapota Mulleri*, Bleekrod; *Mimusops Kauki L*; *M. dissecta*, Hooker; *M. Hookeri*, A.D.C., *M. Manilkara*, Don; *M. Ballota*, Blume; *Achras balata*, Aublet; *Lucuma mammosa*, De Vriese.

VERNACULAR NAMES.—Paarden vleesh (Dutch), Horse-flesh; Bullet tree; Bolletrie and Boerowè by the Arrawak Indians.

GEOGRAPHICAL DISTRIBUTION.—Demerara; Berbice; British Guiana; Antilles; Jamaica and Surinam.

One of the first writers on this substance was Professor Bleekrod, who communicated some information as to the plant and its product to the Society of Arts, in 1857.† He also described and named the plant as *Sapota Mulleri*. In 1860 Mr. Walker‡ communicated samples, &c., received by him from Dr. Van Holst, of Berbice, to the same Society; and in 1864 Sir William Holmes also drew attention to the same subject.§

The tree is a large one, with a trunk of about 6 feet in diameter, and furnishing a wood much sought after as a building material. The Dutch name, Paardenoleesch, is given on account of the wood being of the colour and having the appearance of horse-flesh. The bark is thick and rough, and the fruit is of the size of a coffee berry, sweet, like a plum, and with a hard white kernel, which yields an oil bitter in taste. The leaves are glossy, oval, and acuminated. The milk is drunk by the natives, and when diluted with water, used as cow's milk. The trees grow in groups, and in alluvial soil.

The "Balata" gum is of a character somewhat between caoutchouc and guttapercha, combining in some degree the elasticity of the one with the ductility of the other, freely softening and becoming plastic, and easily moulded under the influence of hot water.

What small parcels were sent to this country met with a ready sale, and were remarkably free from adulteration. But, unfortunately, through the difficulty of collection, the undertaking being so dangerous and unhealthy, the supply of this excellent and most desirable article has fallen off.

Balata is collected by making incisions in the bark about 7 feet from the ground, and a ring of clay placed round the tree to catch the milk as it exudes. The yield is said to be in profusion, especially at the time of the full moon

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* Encyclop. Britann.: Article "Gutta-percha."
† Jour. Soc. Arts, London, Oct. 8, 1857.
‡ *Ib.* Aug. 24, 1860.
§ *Ib.* March 4th, 1864.

—a statement with regard to milky juices which is adhered to by natives in all parts of the world—and the operation can be repeated every two months in the rainy season. It takes six hours to bring about coalescene by simple atmospheric influence, but very quickly by boiling in water. A large tree is said to yield as much as 45 lb. of dry gum.*

II.—INDIAN SOURCES OF SUPPLY.

PAUCHONTEE, OR INDIAN GUTTA TREE.

Dichopsis elliptica, BENTHAM.

Natural Order—*Sapotaceæ*.

SYNONYMS.—*Bassia elliptica*, Dalzell; *Isonandra acuminata*, Lindley.†

VERNACULAR NAMES.—Indian Gutta Tree; Pauchontee, Pauchoontee or Pashonti; Pauley or Pali Tree.

GEOGRAPHICAL DISTRIBUTION.—Wynaad; Coorg; Travancore; Anamally and Neilgherry Hills; Sholah Forest; Cochin; Sichar; and according to General Cullen, "appears to be common in all the forest tracts at all within the influence of the south-west rains."

This tree, which is now placed in the same *genus* as the true guttapercha, is a large one, from 80 to 100 feet high, was first met with by Mr. Dalzell in North Canara, near the falls of Goirsuppah, in 1849. Since that date, General Cullen and Dr. Hugh Cleghorn have used every exertion to bring the substance prominently forward. The gum is obtained by tapping, a pound and a half being obtained from one tree by five or six incisions, a large tree yielding as much as 20 to 40 lb. of sap. Many experiments have been made with specimens of the raw milk, *i.e.*, milk simply dried after taken from the tree. The result of these experiments have shown that for telegraphic purposes it is wanting in some essential qualities, but it has been recommended as a sub-aqueous cement or glue. When dissolved in ordinary guttapercha solvents, it, after the evaporation of the solvent, remains for some time soft and viscid, and partakes somewhat of the characteristics of birdlime. When cold it is hard and brittle. Without wishing in the slightest degree to throw doubt or discredit on the many and valuable experiments made, I would suggest that good samples be collected. I have not the slightest doubt, from the scientific aspect of the case, as well as from practical experience and experiments at home and abroad, that many a parcel of what would otherwise be good guttapercha is spoilt through not being *well boiled immediately* after collection from the tree. At present, this is the only way in which I can see a possibility of ascertaining whether this product can be utilised, and I have the more hope that it can, from the fact that its structural character has led the plant to be placed in the same *genus* as the guttapercha tree: structural affinity being a wonderfully safe index in numerous instances to chemical affinity also. There are in India various species of *Isonandræ* and other closely allied sapotaceous *genera*, but I have found no mention nor heard of their yielding any milky juices likely to prove of commercial value. It would be well if experiments were tried with the products of these trees.

CATTIMANDU AND OTHER EUPHORBIUM GUMS.

Euphorbia cattimandoo, and other species.

Natural Order—*Euphorbiaceæ*.

Euphorbia cattimandoo, of W. Elliot, is found in Vizagapatam, and is variously known under the vernacular names of Cattimandoo, Catemandoo, or Kattimundoo.

The product of this tree was first brought to notice by the Hon. W. Elliot, and a prize medal was awarded for the substance by the jurers of the Exhibition

* *Trinidad Chronicle*, September 2, 1873.

† Under this name, Dr. Hugh Cleghorn wrote a very valuable report in 1858.

of 1851. This Euphorbia grows to the size of a shrub or small tree, and the milk flows out freely when a branch is cut. The natives use the milk as a cement to fasten knives in handles, &c. Under the influence of heat it becomes soft and viscid, and when dry it becomes very brittle. The same remarks as to the probable utility of "Pauchontee," apply also to this and following substances, although in a somewhat limited degree.

Euphorbia tirucalli, of Linnæus, known vernacularly as the Milk hedge or Indian tree spurge, tirucalli and the Lunka sij, is found in the Coromandel, Malabar, Bengal and is, in fact, a very common plant in various parts of India.

This succulent unarmed plant often attains a height of 20 feet, and its inspissated milk is used for various purposes chiefly medicinal, in India, and has been recommended as a substitute for gutta-percha; but like Gum Euphorbium, it has a very acrid character, and the collection of it is a very dangerous operation to the eyes. When dry it bocomes very brittle, but when warmed in water has a certain amount of plasticity.

Alstonia or Pala Gum.

Alastonia scholaris, Robert Brown.

Natural Order—*Apocynaccæ.*

Synonyms.—*Alstonia oleanrifolia*; *Loddidge*; *Echites scholaris*, Linnæus.

Vernacular Names.—Mookum pala; Pala; Chatinn; Eerellay-palay; Ezhilaip-palai; Edakulapala; Edakulatariti; Edakula-ponna.

Geographical Distribution.—Travancore, Coromandel, Assam, and Ceylon.

This tree attains a height of 50 feet, and its wood and bark are much valued in India for their medicinal qualities. The tree yields an abundant milky juice, which was recommended as a substitute for gutta-percha, amongst others, by Mr. Ondaartjee, who brought the substance before the notice of the Society of Arts in 1864.* It is stated to readily soften in hot water, take impressions readily, and to retain these impressions when cold. I have only had very small specimens in my possession, so am unable to form any decided opinion. Good specimens of this and other like substances would be acceptable.

Mudar Gum.

Calatropis gigantea Robert Brown.

Natural Order.—*Asclepiadaceæ.*

This plant known also under the name of *Asclepias gigantea*, of Willdenow, was very early described by Rheede in his Malabar Plants, under the name of Ericu.

Vernacular Names.—Gigantic swallow-wort; Yercum; Yerica; Nella-jilledoo; Akund; Mudah; Ark.

Geographical Distribution.—throughout the peninsula and Southern Provinces of India.

This shrub is found in waste places, and grows to a height from six to ten feet. Ten average shrubs are said to yield one pound of a gutta-like substance, which becomes plastic in hot water and other ways behaves like gutta-percha. There is also another species said to yield the same characteristic milk, viz., *C. procera*, but I have not been able to procure specimens.

III.—CEYLON SOURCES OF SUPPLY.

In Ceylon there are species of *Dichopsis*, *Isonandra*, and other allied *genera* belonging to the natural order: *Sapotaceae*. Specimens of their inspissated juices I have not seen. When I passed through Point de Galle, in 1874, I wrote to the late Dr. Thwaites, the talented Director of the Government Gardens at Peradeniya, with regard to the question of gutta-percha, and received a quick and courteous reply, by which it appears that the natives do not collect any of the gutta, even if the trees yield it in appreciable quantities. This agrees,

* Jour. Soc. Arts, London, vol. xii. xii. 39., Feb., 1864.

too, with information I have received from native and other sources of information. Dr. Thwaites also remarked that some years ago he sent the inspissated juice of one species to Sir W. J. Hooker, but that the report on it was unfavourable.

Certain parts of Ceylon having a climate,* so similar to that of the Malayan Peninsula and Archipelago, it seems probable that here would be found the best localities for the acclimation and cultivation of the true gutta-percha tree. I have recommended the adoption of this course, and sincerely trust that efforts will be made in that direction. It is also probable that the island contains many indigenous pseudo-guttas, which might be made use of.

IV.—AFRICAN SOURCES OF SUPPLY.

At the Cape of Good Hope there are many species of Euphorbias which are said to yield a substance very similar to Cattimandoo, but hitherto I have only been able to see fragments, and thus have been precluded from making any experiments. Like the *Euphorbia officinalis* the juice is so acrid as to give intense pain and irritation to any part of the body with which it may come in contact, especially the eyes and nostrils. Dr. J. Crombie Brown, whilst holding the post of Government Botanist at the Cape, paid much attention to the subject, and favoured me with much correspondence upon it. Our united efforts bore no fruit. The substance has been well spoken of as an anti-fouling dressing for ship's bottoms.

Mr. Baxter, whilst on the Niger Expedition, collected a specimen of *Chriysophyllum* (Sapotaceæ) yielding a substance like gutta-percha, but no specimen seems to exist. Tropical Africa should indeed be rich in such substances, and doubtless such will prove to be the case when careful search and enquiry is made.

With regard to the whole question of the Pseudo-Guttas, Balata should most certainly receive attention, and efforts should be made by the Governmet to introduce it into Ceylon and elsewhere. Pauchontee, too, should receive attention, and the possibility of the utilization of the rest of the group not denied till further trial bas been made.—J. C.—*Indiarubber and Guttapercha Journal.*

THE SILVERTOWN INDIARUBBER, GUTTAPERCHA, AND TELEGRAPH WORKS.

A peculiarly interesting and instructive excursion for our Colonial and Indian visitors took place on Thursday, June 10, when a representative party of two hundred ladies and gentlemen enjoyed an opportunity of inspecting these important works by special invitation of the directors of the company. The magnitude of the work renders it difficult for an exhaustive survey to be made of the different processes carried on in the establishment within the necessarily limited space of time at the disposal of an excursion party, but a carefully planned and well carried out programme enabled the visitors to obtain a comprehensive view of all the more striking features of the manufactures. To give an idea of the extent of the establishment it may be stated that the works, having an important river frontage, cover an area of 15 acres, the floor area of the workshops amounting to 10 acres. In busy times as many as 2,100 workpeople are employed on the premises. The company owns four specially fitted steamers of the collective carrying capacity of 12,000 tons. One of these steamers, the "Silvertown," now loading cable for the west coast of Africa, is the largest telegraph ship afloat. To drive the different machinery used in the works, 47 steam engines and 31 boilers are employed. The works have for some time past been lighted by electricity, the object being to illustrate the adaptability of the electric light for factory use, and to establish the fact of its economy as compared with gas when used on an extensive scale. The installation com-

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* *Vide* **Thwaites'** ***Flora Zeylanica*** **(Preface).**

prises 137 arc lamps of 2,000 nominal candle power inside the buildings, and 10 of 3,000 nominal candle power in the yard. Nearly 800 incandescent lamps are at present in working order, distributed through the waterproof, hose, belt, and other workshops of the indiarubber department, the ebonite shops and general offices. The number will be increased to 1,100 when the engineering and instrument departments are fitted up. The whole of the instruments and fittings, dynamo machines, cotton-covered wires, arc lamps, leads, switches, &c., have been made on the works, and the installation has been carried out entirely by the permanent staff of the electric lighting department.

The colonial representatives were brought from London by special steamer, and were first conducted to the guttapercha department, where the different processes of purifying and treating guttapercha were shewn. Guttapercha, the gum of the tree *Isonandra gutta*, is principally obtained from the Malay Peninsula and the islands of the East Indian Archipelago. When it arrives in this country it contains frequently as much as 25 to 30 per cent of impurities, chiefly sand and bark. In the cleaning and masticating workshop the raw material was seen. The boilers, cleaners, and masticators, where the natural juice is removed and the material made homogenous, were shown in operation. Hydraulic presses are used to force the gum in a plastic state through exceedingly fine wire gauze to remove the impurities. When the guttapercha is strained it is rolled and stored until required for use. In passing to the wire-covering department the visitors inspected the engines which supply the motive power to the washing machinery, and the pumping engine which raises the water for the 31 boilers in different parts of the works from a well over 500 feet deep. The water, when raised from the well, is purified by the Porter-Clark system before being used in the boilers.

The department where the copper-wire conductor is formed was then visited, and the process of covering the conductor with guttapercha was first witnessed. The core of the submarine cable is formed by drawing it through a specially-constructed die containing plastic guttapercha under pressure, whence it issues coated to the required thickness, and is then hardened in cold water and automatically coiled on bobbins ready for inspection. This department can produce about 40 nautical miles of guttapercha every 12 hours.

The visitors then inspected the moulding of various articles and the making of bosses for spinning machinery from guttapercha, and, after going through the testing rooms, the submarine cable workshops were reached, where the sheathing of the cable now being manufactured to connect the West Coast of Africa with Europe was to be seen. The cable factory turns out about 26 nautical miles every 12 hours. A visit of inspection was then paid to the "Silvertown," then engaged in taking in cargo, several torpedo experiments being carried out meanwhile, amongst the most remarkable of which was the throwing up of a large column of water to the height of 80 feet. The manufacture of electric-lighting conductors was then witnessed, special attention being directed to a conductor manufactured for a French company, of which the copper alone weighed about 10 tons to the statute mile. Luncheon was then served in one of the buildings, Mr. Silver, the chairman of the company, presiding.

After luncheon, the manufacture of various types of battery was inspected, the Leclanche (of which the Silvertown Company is sole licensee for Great Britain and the Colonies), large batteries used on men-of-war for firing broadsides, and smaller types for torpedo work, &c. In the same shop is carried on the manufacture of carbon rods for electric lighting.

The electric-lighting department was then visited, and a demonstration of transmission of power by electricity was made. The torpedo shop and the instrument department, where about 70 skilled hands are employed, having then been successively inspected, the indiarubber department was reached, and the different processes of its preparation passed under survey. Indiarubber is chiefly received from the Brazils (Para, Ceara, &c.), and from Guayaquil, British India and Madagascar. It is collected from the *Jatropha elastica*, in a similar

manner to guttapercha, but, with the exception of Para rubber, the impurities are greater. The first process of manufacture is to get rid of these impurities by cutting the gum into pieces and thoroughly washing and amalgamating it; after which it is dried and mixed with the materials necessary for its different purposes. It is usually mixed with sulphur, then moulded into the required forms, and exposed to a heat of about 300° Fahr., which causes a chemical action, completely changing the nature of the material, and fixing it in the shape designed. When the quantity of sulphur and the period of exposure to heat are increased, ebonite or vulcanite is produced.

The manufacture of valves, railway buffers, washers, rubber rings, mats, wheel tires, tennis balls, ink erasers, bottle stoppers, &c., hose or pipe making, and belting or driving bands was then briefly surveyed, the chemical laboratory, a very attractive department was glanced at, and the visit concluded with the inspection of the ebonite shops, where the manufacture of a large variety of articles was witnessed. The company then returned to town by special train.—*Colonies and India.*

PROPOSED CULTIVATION OF INDIARUBBER IN GERMANY.

The above question is by no means a new one to German scientific men, but the first systematic treatment of the subject is due to the labours of Dr. Kassner, who has recently issued a pamphlet summarising the requirements of the case. According to the practical view he takes of the matter, it would be necessary to regard the chances of obtaining from the plants some other substances besides India-rubber, in order to render the production of the latter as economical as possible.

In reviewing the progress made on this important point, the *Chemiker Zeitung* mentions that many families of *composita*, *euphorbiacæ*, *apocyneæ*, and *urticineæ*, which grow in Germany, have been found to contain a milky juice in which globules of India-rubber are said to have been discovered; but on this latter point there would seem to be a certain amount of mystery in technical circles. According to Dr. Kassner, the plant worthy of most serious attention is the *Sonchus Oleraceus*. By judicious cultivation, and the choice, for sowing purposes, of the seeds obtained from plants containing abundance of juice, he hopes to increase the quantity of the latter; relying upon the experience of beet and carrot growers. The most valuable portion of the treatise is, however, that which deals with the chemical composition of the plant in question; his arguments as to conditions necessary for its successful cultivation being enforced by illustrations derived from analyses of the ash obtained by burning it.

Experiment having detected in the plant the existence of a relatively large quantity of potash, and a less amount of phosphoric acid, Dr. Kassner urges the necessity of the soil in which it is grown having a large proportion of the former substance. The products of the plant he classifies as folows:—

(1) 3 to 4 per cent of an extract obtained by benzine or sulphuret of carbon, containing:—
- (*a*) 0·187 per cent of the volume of the so called hay of pure India-rubber.
- (*b*) Green and yellow dyeing substances soluble in alkaline fluid, and giving effective lac-colours.
- (*c*) Wax and grease.
- (*d*) Indifferent substances (like the lactucerine obtained from the *lactuarium*) with valuable properties.

(2) About 5 per cent of pappus-hair, a tender flexible wool, which should answer for the manufacture of paper.

(3) 92 to 93 per cent of dry fodder, with a proportion of 2½ per cent of nitrogen, and 15⅝ per cent of albumen.

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rubber obtained exaggerated price," he observes, "all went well." The exports of rubber in 1883 reached 9,648 tons, in which England participated to the extent of 4,552 tons; America, 4,696, tons, and France 400 tons. The exports in 1884, amounting to 9,887 tons, were thus distributed:—England, 4,269 tons; America, 5,159 tons; France, 361 tons; and other countries, 98 tons.

MADAGASCAR.—The British Vice-Consul in Madagascar, Mr. Pickersgill, in a report on the trade and commerce for the year 1884, referring to the various natural products, makes the following interesting remarks:—"India-rubber deserves attention, especially from those who are interested in keeping the European market supplied with this most valuable product. The indigenous vine yields an excellent quality of rubber, but the supply is yearly diminishing. It is now found only in the depths of the forests, far from the security of settled habitations, and is consequently obtained at considerable risk. No provision is left or made for future needs, the vines being entirely destroyed by the reckless men who wander in search of them. That a properly managed plantation of this native product would turn out to be a profitable speculation I have very little doubt. An experiment made by myself a few years ago, in the north-west, was entirely satisfactory, as far as showing the possibility of extending the growth of vine—a single fruit of it, picked up in the bush, was found to contain no less than 72 seeds, all of them sprouting. These were taken to a piece of swampy ground, and planted at the feet of tall trees already growing therein, where they readily struck root, and for some time flourished, until an unexpected rise in a neighbouring river overflooded and carried them away. It would probably take from four to five years for the vine to grow large enough to endure much cutting. The natives who witnessed the above experiment were fully convinced thereby of the practicability of cultivating the rubber, but such investments for the remote future are not attractive to them. After the first years of waiting there would be little need for outlay on a plantation of this vine, as the cost of preparing the rubber for the market is very trifling."

THE INDIARUBBER TREE.

(*Castilloa Elastica.*)

Now that the cultivation of the different species of rubber is receiving such attention in this Presidency, it may be interesting to detail under what remarkable circumstances of peril and privation the principal species, *Castilloa elastica*, was introduced into this country. The plants which were the parent stock of all the present Indian trees, suffered shipwreck during their transmission here, and only for the devotion to science of the gentleman who had culled them from their native soil, would have been irretrievably destroyed. This gentleman amid all the perils attendant on a shipwreck, clung to the case containing his beloved plants with invincible tenacity, and brought them safely from the doomed ship. In a word, the adventures of Mr. Robert Cross in the Isthmus of Darien, whither he proceeded expressly for the purpose of collecting the seeds and plants of the *Castilloa elastica*, read more like a page of romance than a veritable history.

Mr. Cross left Southampton for Panama in the prosecution of his quest on the 2nd May, 1875, and reached the latter place on the 26th of the same month. He there ascertained that the *Castilloa elastica* chiefly yields the India-rubber of commerce exported from the Republics of Central America, Mexico, New Granada, and Ecuador, and that the tree is found growing from 1° south latitude to 20° or more north of the equator, though he rightly inferred that in such a wide expanse of country there must be numerous varieties which bear so close a resemblance to each other, that they can only be distinguished by their different sizes and more or less robust growth. Though a great deal of Indiarubber may be obtained from the forests on the Pacific coast south of Panama, Mr. Cross found that the export of the product from those regions was

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Lauracea with straight smooth stems towered to the height of 150 feet before a branch was reached, and a massive species of *Bombax*, called by the Indians *Quipo*, had frequently a clear trunk of 200 feet high, with a flat crown of green foliage like an umbrella, "giving to the hills a grandly imposing and majestic appearance." The rubber saplings always appeared to grow most freely on the banks of little cool clear streams, the roots often meandering down to the edge of the water. They abounded also in deep rich soil along the base of the hills, and in both deep and shallow ravines. At length Mr. Cross found a rubber tree loaded with unripe seed, and this he watched for fifteen days until the seed ripened, and to facilitate collection, he cut the tree down and gathered all the seed. Here Mr. Cross made a disappointing discovery; most of the seeds had already begun to germinate, so it could not be expected they would endure a journey of any distance, without having their germinating power exhausted. It may here be important to note that the seeds have no hard covering, and, when ripe, are nearly as easy to bruise as green peas, and that it seems natural to them, enveloped as they are in a soft juicy mass, to grow as soon as the fruit falls to the ground, or even sooner. Mr. Cross despatched his seeds without delay, and now resolved on securing *plants*, as he was apprehensive the germinating powers of the seeds would be exhausted before they reached their journey's end. He now had an opportunity of observing the native process of preparing Indiarubber. The milk-like juice of the tree, which, when congealed, forms Indiarubber, is obtained by cutting out a groove or ring of bark around the base of the trunk. The milk exudes from the bark into the channel thus formed, and large leaves are placed so as to receive it as it trickles down. The tree is then felled, and rings or channels are cut around the prostrate trunk, at about twelve or fourteen inches apart. Beneath these, leaves or vessels are placed, into which the milk flows, and the contents of all these vessels are afterwards put into a hole previously dug in the ground. The milk left in this way becomes curdled in about two weeks. The Indians use the soft green stem of a climber—a species of *Ipomea*—which, when bruised and stirred about in the milk, congeals it in a few minutes. By this last method the milk takes up all the watery particles it may contain, and the produce is described as of an inferior kind, possessing a strong peculiar smell, and continually sweating a black ink-like water. Soap is resorted to by some collectors, and also wood ashes which contain potash; alum and salt are likewise used. Mr Cross expresses his opinion that by whatever method manufactured, the rubber ought to be prepared *rapidly*, which will ensure its being perfectly dry and free from impurities. Judging from the rapid growth of rubber trees at Burliar and other places on the Nilgiris, we think we are justified in assuming that at no distant date the manufacture of rubber will be undertaken here, consequently these details appear worth noting. Mr. Cross himself made some rubber in the following manner, from a recipe given him by Mr. Mathew Gray, a member of one of the largest rubber manufacturing firms in London. He procured the milk of the *Castilloa* which he kept a few days until it thickened, and this he spread out on a piece of zinc exposed to the sun, and stirred it assiduously until it became firm, when he took it off the zinc and hung it up to dry. By this rough and simple process, Mr. Cross obtained a very satisfactory piece of Indiarubber. Rubber trees, we are assured, grow to a height of 200 feet and attain a diameter of 8 feet. From such a tree at least 150 pounds of Indiarubber could be collected.

We have not space to detail the perilous adventures of Mr. Cross in obtaining the plants on which he had set his heart. Suffice it to say that he secured these, and packing them carefully in cases, embarked with his treasure on board the "Shannon" a large steamer of 4,000 tons burden. The "Shannon" was wrecked, but amidst all the danger and confusion, Mr. Cross only thought of his plants, which he bore safely away in the boat with him. From those plants, culled and cared for under such romantic circumstances, sprang the numerous flourishing groves of *Castilloa Elastica* which now adorn, Burliar and other places in South India,

and which we are confident are but the nucleus of what will develope into a collossal industry.

One would think after perusing the foregoing that Government hastened to reward the man who had performed such great public service for the benefit of the community. The gallant explorer did not receive the smallest recognition for his great services. He was at Nilambur establishing the growth of the rubber trees which he had introduced into this country after such toil, danger, and privation, and in reply to some overtures made on his behalf to the Secretary of State, a telegram was received. What the purport of this telegram was we know not, but its contents so disgusted the explorer, that he "shook the dust from off his feet," and departed to seek "fresh fields and pastures new.—*Nilgiri Express*.

INDIARUBBER IN THE DUTCH EAST INDIES.—N. McNeill, Esq., the acting British Consul at Batavia, informs us that the exports of Indiarubber during the years 1881, 1882, and 1883 were, respectively, 541, 765, and 1,217 piculs (a picul equals 140 lb.). The trade in this article of produce has been very dull lately. The Indiarubber is obtained by the natives from the bark of the trees, and always contains more or less woody fibre intermingled with it. It is also occasionally adulterated with woody fibre to increase the weight. The island of Sumatra is richer than Java in the production of Indiarubber, the principal producing districts being Bencoelen and the Lampongs. The rubber obtained from the latter is generally considered the better of the two. The prices have varied during the past year from 120 to 80 florins for Bencoelen and from 160 to 110 florins for Lampong per picul. (The Dutch East Indian florin is worth 1s. 8½d). It is better to attach fixtures to a lathe spindle by means of the screw than to hold them by inserting a shank in the socket where the centre is put. The turning centre should run perfectly true, and where a practice is made of inserting drills, reamers, shanks, and other tools, the surface of the centre seat may be so marred and enlarged that the rotation of the centre will be out of line with the axial rotation of the spindle. —*Indiarubber and Guttapercha Journal.*

CAOUTCHOUC.

By PROF. C. F. CHANDLER, Ph. D., M.D., Prof. Anal. Chem. School of Mines, Columbia College.

Caouthouc may be roughly defined as a peculiar substance composed of carbon and hydrogen, found in suspension in the milky juice of a great many different families of plants. It has been stated that all milky vegetable juices contain it; but this is not the case, many of these juices yield gum resins free from caoutchouc.

PROPERTIES AND COMPOSITION OF THE JUICE.—Caoutchouc juice or sap has been imported from time to time into England in considerable quantities, but it is found more economical to prepare the crude rubber where the juice is collected. It resembles ordinary cow's milk in colour and consistence. Its specific gravity varies from 1·012 to 1·041. Several circumstances may conduce to give the commercial juice a grayish brown, milky gray, or pale yellow colour, but the pure juice as it issues from the tree is white. Dr. Adriani (*Chem. News* II. 277, 289), who made some valuable experiments upon the fresh juice of the *Ficus elastica*, tapped by himself, says that, as the general result of his experiments, the quantity of solid matter contained in the milky juice decreases according to its being collected from incisions made in the higher, and consequently younger, parts of the plant. The tree which yielded the juice for his experiments was a young plant 2·25 mètres in height.

Amount of juice evaporated.	Height at which it was taken.	Total residue.	Per cent.
0·183 grms.	0·30 mètres	0·046 grms.	25·15
0·395 "	1·74 "	0·095 "	24·05
0·143 "	2·10 "	0·030 "	20·98
0·825 "	Top.	0·145 "	17·70

These figures prove, as stated above, that the juice in the older parts of the plant does contain more solid matter than in the younger parts. Old trees, than, furnish the richest juice, and Mr. Griffiths states that the juice of the reflex roots, which lie exposed, is richer in gum than any which is subsequently drawn off.

The following analyses have been published:—

JUICE OF FICUS ELASTICA (ADRIANI).

Water	82·30
Caoutchouc	9·57
Resin soluble in alcohol, but not in ether	1·58
Magnesia, combined with peculiar organic acid	4·49
A substance soluble in water and alcohol, but not in ether (sugar?)	0·36
An organic substance soluble in water, takes a yellow tinge with alkalies (dextrine), and traces of salts of lime and soda	2·18
	100·48

JUICE OF SIPHONIA CACHUCU (FARADAY).

Water, acid, &c.	56·37
Caoutchouc	31·70
Substances soluble in water, not in alcohol	2·90
Albuminous precipitate	1·90
Peculiar bitter colouring matter, a highly azotised body } Wax }	7·13
	100·0

An apparent paradox has been announced in the fact that India-rubber when stretched and exposed to the heat contracts instead of expending—a fact very contrary to common experience as the result of the application of heat. This is explained, however, by the fact that the rubber is very porous and filled with air-cells, which, when the rubber is stretched, assume an elongated shape. When heat is applied it of course expands the rubber to a certain degree, but, at the same time, it expands the air-cells, which, by shortening their longitudinal axes, produce a virtual contraction of the rubber.—*Indiarubber and Guttapercha Journal.*

CELLULOID.

Celluloid is certainly not rubber, but in certain industries it is to some extent associated with, or substituted for, rubber; therefore some account of its composition and the methods of producing it may not be unacceptable to our readers.

Celluloid may be briefly defined as a species of solidified collodion, proceced by dissolving gun-cotton (pyroxylin) in camphor with the aid of heat and pressure. The nature of this product, and the methods of procedure employed in its manufacture, will be found described in what follows. First let us devote a few lines to an account of the materials employed; and here, as of prime importance, we must begin with gun-cotton.

When cellulose or wood fibre (under which term are included common

cotton-paper or paper-pulp, the refuse of cotton mills, and vegetable fibre of every description) is immersed for a few minutes in a bath composed of a mixture of strong nitric and sulphuric acids, then removed and washed and dried, it will be found to have acquired new and remarkable qualites. In external appearance there is nothing to indicate that any change has taken place, but when the test is made it will be found to have become highly inflammable and (if the action of the bath has been sufficiently prolonged and intense) even highly explosive. Wood fibre, or, to give it its proper chemical name, cellulose, thus treated is said to have been nitrated, and the resulting product is termed nitro-cellulose, pyroxylin or gun-cotton. It has received the latter appellation because, when properly prepared, it can be used as a substitute for gunpowder, which indeed, it considerably excels as regards its explosive qualities. There are many other substances besides cellulose which, when treated in the manner above described, acquire similar inflammable or explosive qualities. Sugar, starch, and glycerine may be mentioned as examples; of the last-named substance the nitro-compound is nothing else than that terrible explosive agent nitro-glycerine, the basis of dynamite.

But the cotton (supposing, for illustration, that we are using this common form of cellulose), besides becoming highly inflammable and explosive after the treatment we have above described, also acquires another quality. It is found now to be readily soluble in certain *menstrua* which are utterly without action on common cotton. For example, it will gelatinize and quickly disappear in a mixture of alcohol and ether, forming a thick, transparent liquid. This is the same material used by photographers, who, in taking a picture, first spread a thin film of this solution, called collodion, upon a glass plate. The ether and alcohol, being volatile, quickly evaporate, leaving behind a thin, smooth, and tenacious membrane or film of gun-cotton, which serves as the medium of holding the sensitive silver compound used in taking the photographic image. It is upon this property of ready solubility of gun-cotton that the manufacture of celluloid depends. Professor Seeley was the first to observe that gun-cotton would dissolve in an alcoholic solution of camphor, and after many experiments, the brothers Hyatt succeeded in perfecting and patenting as procedure whereby camphor with finely pulped gun-cotton is made to exert its solvent effect upon this substance, with the aid of heat (fusion) and pressure, in a close chamber, to prevent the volatilization of the camphor.

The following is an abstract of their method:—

"A machine similar to that used in grinding paper-pulp is first employed to grind the gun-cotton in water to a fine pulp. This pulp is then subjected to powerful pressure in a perforated vessel to extract the bulk of the moisture, but still leaving it slightly moist for the next operation. It is now thoroughly incorporated with finely comminuted gum-camphor in the proportion of one part by weight of the camphor to two parts by weight of the pulp. With the camphor and pulp," the patentees further state, "they can also incorporate any pigments, colouring matter, or other materials that may be adapted to the requirements of the articles into which the product is to be manufactured."

Having obtained the desired mixture of pulp, camphor, and pigments, the next step in the process is to subject the mass to powerful pressure, in order to expel from it the remaining traces of moisture, and incidentally to effect also the more intimate contact of the camphor with the pulp. The dried and compressed mass is then put into a mould open at the top, into which fits a solid plunger. The vessel is next placed in a hydraulic (or other) press, and heavy pressure applied to the plunger is brought to bear upon the mixture. Whilst thus under pressure it is heated by means of a steam jacket surrounding the chamber, or by other means, to a temperature of about 300° Fahrenheit. At this temperature the camphor fuses, and its volatilization being impossible, the melted gum dissolves the gun-cotton pulp, or, to use the words of the patentees, "converts" it. It is further stated by the patentees that the process of transformation is rapidly effected when the right temperature is reached, and

the product which results is the homogenous solidified collodion known as celluloid. After the mass is taken from the press it hardens and acquires that extraordinary toughness and elasticity which are the distinguishing characteristics of the product. And it is a noteworthy fact that a large portion of the camphor it contains appears to be permanently held or combined with it (to use a convenient, though not strictly correct, term), so that the tendency of the camphor to volatilize is practically arrested.

There are numerous varieties and modifications of the abovenamed procedure, which it would take too much space to enumerate. Upwards of ninety patents have been taken out in connection with the process and the machinery employed.

The applications of celluloid are legion, and only the more prominent can now be mentioned. It is best known as a substitute for ivory. In this capacity it has been very successfully employed. So perfect is the resemblance that a close inspection is required to distinguish the counterfeit from the genuine. The absence of "grain" is, perhaps, the readiest peculiarity by which celluloid goods may be detected, but for all practical purposes it is not only as good as ivory, but, in some respects, better than that material. It possesses the strength and elasticity of ivory, but it does not warp or discolor with age.

On these accounts it is now largely used instead of ivory in making piano and organ keys, and billiard balls, combs, backs of brushes and hand mirrors, frames, handles, &c. Not the least of its advantages is the fact that it can be moulded so that the most delicate and elaborate decoration can be produced at a fraction of the cost of the same ornamentation executed in ivory.

For most purposes hard rubber, on account of its cheapness, can hold its own against celluloid very well; but tortoise shell, malachite, amber, pink coral and other costly and elegant materials are so successfully imitated that an expert must look sharply to tell the original from the copy. In imitation of tortoiseshell it is made in such articles as combs, card cases, cigar cases, match boxes, napkin rings, &c. The pink coral, so popular for jewellery, is admirably imitated and sold at low prices, as are also the imitations of malachite and amber. It is a very common substitute for the last-named material in the mouthpieces of pipes, cigar-holders, &c.

As a substitute for porcelain in dolls' heads, celluloid stands any amount of hard usage. It is used instead of hard rubber in many spectacle and eyeglass frames; and also for shoe tips, emery wheels, knife sharpeners, &c. In combination with linen, cotton, or paper, it is manufactured into shirt bosoms, cuffs, and collars, which are at once elastic, strong and durable, and when soiled only need to be wiped over with a damp sponge to restore them to their original lustre.—*Indiarubber and Guttapercha Journal.*

RESINOUS AND GUMMY SUBSTANCES.

(From Spon's Encyclopædia &c., Part V.)

GUTTAPERCHA.—This name, as naturalized in European commerce, embraces the inspissated juices of several species of sapotaceous trees growing wild in peninsular and insular Malaysia. Their range has been defined as lying between 6° N. and S. of the equator, and between 100° and 120° E. long.; this has been more recently curtailed to 4° N. and 3° S. lat., the finer varieties being confined between 3° 50′ N. and 1° S. lat., where the air is very humid, and the temperature ranges about 19°-32° (66°-90° F.).

The Malay word *gutta* (variously spelt) signifies "gum" simply, while *percha* is the name of the tree. The *guttas* distinguished by the Malays are as follows:—(1) *Gutta-susu*, obtained from a scientifically-unknown tree, now extinct except in the interior of Perak; the product is the most esteemed of any, on account of the firmness of texture. Must not be confounded with the Bornean article of the same name, which is a kind of indiarubber. (2) *Gutta-taban*, the

"guttapercha" of commerce, which will receive further attention presently. (3) *Gutta-rambong* and (4) *Gutta-singgarip*, kinds of indiarubber, and described in that section. (5) *Gutta-puti* or *gutta-sundek*, the product of an undetermined species of *Dichopsis* [*Isonandra*], frequently met with on this Sayong and Meeru ranges (Perak). It is obtained and prepared in the same manner as *taban*, but is much whiter and more spongy, and valued at little more than ¼ the price of *taban*; of it, some 484½ *piculs* (of 133⅓lb.) were exported from one port in 1877. (6) *Gutta-julatong*, of unknown origin, often used in Perak for mixing with *taban* and *puti*, thus rendering them very brittle. (7) *Gutta-kotian*, said to be derived from *Isonandra* [*Dichopsis*] *Motleyana*, of the Peninsula, Java, and Sumatra; the product is used only for adulterating. (8) *Gutta-burong*, the milks of various species of *Ficus*, employed as bird-lime, and described under indiarubber.

[Since the preceding remarks have been in type, Beauvisage has published a monograph on guttapercha, see Bibliography (p. 1695), which deserves the attention of all interested in the subject; it is too late to do more here than give a brief epitome of his nomenclature:—*Dichopsis* [*Isonandra*] *Gutta* is called *Gutta-balam* at Pajakomlao (W. Sumatra) and the Lampongs (S. Sumatra) *gutta tambaga* at Lobo Along (W. Sumatra) *gutta-dadu* or *-seroja* in Banka Island, *gutta-derian* in Sokadana (S. W. Borneo and E. Sumatra *gutta-percha* in Malaysia generally, *gutta-taban* in the Riou Archipelago, and *ngiato-mera* or *-to-oen* in Borneo; *Isonandra dasyphylla* [*bintang*], is the *ngiato-bintang*; *I. Motleyana* is *kotian*; *I. macrophylla* is *ngiato-puti*; *I. Benjamina* is *ngiato-wangi*; *I. xanthochyma* is *ngiato-renkan*; *I. quercifolia* is *ngiato-tinang*; *I. rostrata* is the *ngiato-pisang* of Banka; *Dichopsis Krantziana* [*I. Krantzii*] is the *thior* of Cambodia and *chay* of Annam; *Chryso-phyllum rhodencurum* is *karetandjeng*; *Cocosmanthus macrophyllus* is *karetmondjeng*; *Ceratophorus* [*Azaola*] *Leerii* is *balam-tandok*, *-tjabe*, *-trong* or *-sonte*, or *kolan*; *Ceratophorus longipetiolatus* is *benko*; *Sideroxylon*, *attenuatum* is *balam-tima* or *karet-pantjal*. He indentifies *ngiato-dokang* as a *Bassia sp.*; and further enumerates as guttapercha-yielding plants *Bassia sericea Isonandra lamponga*, *I. microphylla* and *I. acuminata*.]

Commercial guttapercha is essentially *gutta taban*, derived from *Dichopsis* [*Isonandra*] *Gutta*, of which there are a white-flowered and a red-flowered variety in Perak, known lacally as *ngiato-puti* and *ngiato-mera*. The supplies from this species are supplemented by some of those previously mentioned; according to Burbidge, the guttapercha obtained from the Lawas district of Borneo is formed of the mingled saps of at least 5 species of *Dichopsis*, the juices of a *Ficus*, and of one or two species of *Artocarpeæ* being not infrequently added as adulterants. The *Dichopsis* [*Isonandra*] *spp.*, flourish best in light rich loam with a rocky subsoil. Many of the most valuable varieties are confined to the hill-slopes at a distance from the sea, each forming a distinct grove of 200-500 trees. Small plants (1-8 ft.) of *D.* [*I.*] *Gutta* are abundant on the granitic formations in Perak up to 3,500 ft. All species are difficult to propagate, except from seed, and are very slow (25-30 years) to attain maturity. For their cultivation, it is recommended to take plants not more than 1 ft. high from the jungles: it is necessary to lift them very carefully, as they have long tap-roots, which are liable to be broken or injured, thus greatly retarding the growth of the plant, or killing it outright. These facts need to be taken into consideration in view of the rapid extermination of the trees which is now taking place. Doubtless large quantities of guttapercha, as of indiarubber, are still to be derived from the little-known interiors of Malacca, Borneo and, Sumatra if at an increased cost; but cultivation, and some system of obtaining the product short of killing the tree, will have soon to be adopted in earnest, if a supply is to be maintained.

In Perak, the guttapercha trees are most abundant on Gunong Meeru, Gunong Sayong, and Bujong; a few large trees still exist on Gunong Babo and the Thaipeng range. In Borneo and Sulu, the Kadyans and their Murut neighbours collect considerable quantities of the gum in the surrounding forests, and convey it to Labuan for sale. A writer in the 'Journal of the Indian

Archipelago' some years since says:—"To the north, the gutta collectors have reached as far as Perak on the Peninsular side of the Straits of Malacca . . . and, on the Sumatran side, as far as Pane and Bila. To the south, the whole of the Johore Archipelago, and the adjoining countries on the E. coast of Sumatra, as far as Palembang (including the forests on the Kampar, Indragire, Tunkul, Rite, Jambi, and Palembang, rivers) now furnish *taban*. On the E. coast of the Peninsula, the knowledge of it has not yet advanced beyond Pahang. To the eastward, it has reached some of the rivers of Borneo, such as Brunei, and Sarawak on the north, Pontianak on the west, and Koti and Passir on the east. It thus appears probable that the range of the *taban* embraces the whole of Borneo." Another author states that this tree is one of the most common in Johore. It is not found in the alluvial districts; but in undulating ground, such as that occupying the centre of the Malay Peninsula between the Indan and Batu Pahat, it occurs frequently, and, in some places, abundantly.

Generally, the collection of guttapercha is carried on immediately after the rainy season: in the dry season, the flow is very tardy, while during the rains, fever prevails, and the exudation is liable to be washed away. In Perak, no particular season seems to be recognized, and Murton was unable to learn whether the yield of the trees varies with the season; but he is of opinion that in wet seasons the guttapercha must contain more water, and need more boiling for its removal. The methods adopted for extracting the guttapercha vary somewhat among the Chinese, Malays, and Dyaks. The mature trees are felled just above the buttresses, by means of axes wielded by men standing on a stage 14-16 ft. above the ground; and the branches are immediately lopped off to prevent the sap ascending to the leaves. In Perak, the felling takes place at 5-6 ft. from the earth, and the top of the trees is also cut off at the point where it becomes too small for ringing. The ringing consists in making incisions in the bark of the felled trunk. The Binna people of the Malay Peninsula cut the bark with a *golo* (small knife) or *parang* (bill-hook) at distances of 6-18 in. apart, around so much of the trunk as is accessible while lying on the ground, at the same time removing about 1 in. of the rough outer coating of the bark on each side of the wound, but without peeling off any of the inner bark. The Malays of the same region strip off a ring of the soft bark about 1 in. wide in each case. In some districts, the bark is beaten with mallets, to accelerate the flow of the sap. The latter exudes for about an hour from each incision, and is caught in palm-leaves, coconut shells, and other receptacles, much, however, escaping to the ground and being lost. The extreme yields may be stated at 2 *catties* and 20 *catties* (of $1\frac{1}{3}$ lb.) per tree, the average being 3-5 *catties*. The differences in yield are not readily apparent, as the trees are usually about the same age. The crude juice, if in small quantity, may be readily inspissated or concreted by rubbing between the hands. But this is rarely done, the rule being to boil the article in water in a *kwali* or iron pan about 15 in. diam. and 6 in. deep, with the addition of various adulterants. The boiling is done partly for the purpose of driving off the water which usually gets mixed more or less with the juice, and gives a stringy and deteriorated appearance to the guttapercha. Among adulterants other than the juices of allied plants, one of the most important is coconut-oil, to improve the appearance; lime-juice (1 pint to 3 gal.) has the property of coagulating the guttapercha immediately on ebullition. Generally in Borneo some 20 per cent of scraped bark is added; indeed, it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red colour is mainly due. On reaching the export warehouses, the various kinds are assorted and sophisticated ready for commerce. The article is exported either in the form of balls weighing 13-20 *catties* (of $1\frac{1}{3}$ lb.), or in large blocks, usually the latter for foreign ports.

The trade in guttapercha is of considerable and growing importance. Our imports of the raw article in 1880 were:—From the Straits Settlements,

62,862 cwt., value 505,821*l*; other countries, 2,994 cwt., 22,051*l*; total, 65,856 cwt., 527,872*l*., being an advance on previous years. Our imports from the Straits Settlements have increased from 19,665 cwt. in 1876, to 21,887 in 1877, 31,036, in 1878, and 49,387 in 1879. From Borneo direct, we received 22 cwt. value 350*l*., in 1876, but none is recorded since. The exports of guttapercha and indiarubber combined from Borneo to Singapore in 1879 were valued at 437,027 dollars or, 91,047*l*. The proportion from each Bornean port was:—Brunei, 27,720 dol.; Labuan (received from the coast), 47,513 dol.; Sarawak, 361,794 dol. Of the figure for Sarawak, guttapercha represents 320,507 dol., leaving only 41,287 dol. for indiarubber. The little port of Sandakan shipped 6,277 dol. worth of guttapercha. The exports of guttapercha from Java for the year 1877-8 were 1,113 *piculs* (of 135½ lb.) to Holland, and 6 to Singapore; in 1878-9, 332 to Holland, 116 to Singapore, and 34 to England; crop of 1879, 555 to Holland, and 274 to Singapore. It has been estimated that the shipments of guttapercha from Sarawak alone during the years 1854-75 have totalled over 90,000 *piculs* (of 133⅓ lb.) representing the destruction of at least 3 million trees. Our re-exports of guttapercha in 1880 were:—4524 cwt., 53,949*l* to Germany; 1,796 cwt., 16,100*l*, to Holland; 1,137 cwt. 13,541*l*., to the United States; 1,072 cwt. 4,604*l*. to other countries; total, 8,529 cwt., 88,194*l*.

The physical and chemical properties of guttaperoha, and its industrial applications, have been described in a section of the article on Indiarubber Manufactures, pp. 1,162-4. It may be added that while exposed to the air and alternations of temperature, it oxidizes and decays rapidly, lasting only about 10 years on telegraph wires suspended in tunnels, but about 20 years when enclosed in iron pipes; yet in the sea, 20 years' exposure produces no visible deterioration.

The approximate London market value of guttapercha is 6*d*.-3*s* 6*d*. a lb. for genuine, and 3*d*.-2*s*. a lb. for re-boiled.

GUTTASHEA.—This name has been conferred upon a substance, somewhat resembling guttapercha, found in appreciable proportion (½ per cent) in shea-butter (see Oils and Fatty Substances, p. 1,410). Beyond what is there stated concerning it, Dr. Letts, who experimented upon the substance for Thomas Bros., Bristol, obligingly writes as follows:—"I did not succeed in isolating from the gum any very definite product. To the best of my recollection, the portion soluble in ether separated gradually as an almost colourless solid, but I could not determine whether or no it was crystalline. I remember that I could get no definite salts or other compounds from either it or the insoluble residue. The only other fact I considered of importance was the odour which the gum evolved on dry distillation, which was exactly like that of indiarubber (when heated). This led me to think that the gum might be allied to caoutchouc." It has been separated in a manner to admit of its industrial utilization, but no application has yet been found for it.

HARDWICKIA BALSAM.—An important oleo-resin is obtained from *Hardwickia pinnata*, a large tree, very common in the dense moist forests of the S. Travancore ghats, and found also in S. Canara. The method adopted by the natives for extracting the balsam is parallel with that current in Brazil for procuring copaiba (see pp. 1639-40). The product is a thick, viscid fluid, bearing the closest likeness to copaiba, from which it may, however, be distinguished by the tests given on p. 1,640. It is used medicinally in India as a most efficient substitute for copaiba.

See also Gurjun, p. 1651.

HOG.—The term "hog-gum" (which must not be confounded with the inferior tragacanth bearing the same name, see p. 1686) is applied in Jamaica to a yellow resin resembling Burgundy pitch in appearance, which escapes as a pellucid juice from incisions in the trunk of *Moronobea coccinea*. It is used for making pitch plaisters and as a substitute for copaiba in Jamaica. In Brazil and Guiana, where it is known as *mani* or *oanani*, it is converted into torches, and employed in pitching boats.

INDIARUBBER (FR., *Caoutchouc*; GER., *Kautschuk*).—The term "Indiarubber," often and conveniently shortened to "rubber," is applied to a large class of inspissated plant-juices, chiefly yielded by the species named on pp. 1627-8. In England, the name "caoutchouc" is restricted to the hydrocarbon which constitutes the main ingredient of commercial rubbers. The plan on which the present article is framed is to commence with a description of the origin and production of the commercial rubbers in their alphabetic order—African (including Mozambique, Madagascar, Liberian, &c.); Assam, Java, Penang, and Rangoon; Central American (including Cartagena, Guatemala, Guayaquil, Honduras, Mexican, Nicaragua, and W. Indies); Para; Pernambuco or Mangabeira—following with other kinds which as yet have no industrial importance, and concluding with statistics of production, export, price, &c. The industrial applications of the rubbers have already been described in the article on Indiarubber Manufactures, pp. 1142-64

AFRICAN.—Much ignorance still prevails concerning the sources and collection of the African rubbers. The Mozambique and Madagascar kinds are obtained from the climbing shrubs *voa-here* or *voa-canja* (*Vahea madagascariensis*), *voa-hine* (*V. comorensis*), and *V. gummifera*. The product of one of these species is said to be much superior to the others, but all are mixed indiscriminately by the natives. The preparation consists in treatment either with salt water or artificial heat. The Mozambique article occurs in orange-like balls; in "sausages," formed of slender strings of rubber wound upon a stick, which is finally withdrawn; and occasionally in smooth pieces of various size termed "cake" or "line." The Madagascar sort consists of shapeless lumps, the better quality having a pink colour, and the lower a black.

Some rubber is produced in Mauritius by *Cryptostegia grandiflora*, and some by *Willughbeia edulis*, the latter found also in Madagascar, Chittagong, and Silhet.

A belt of rubber-yielding plants of different species extends across Tropical Africa from ocean to ocean. Within 20 miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, E. Africa, 11° S., 38° E.), the forest becomes almost entirely formed of indiarubber vines, affording an abundant supply of fine rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the exuding juice, which issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange, like balls, it is taken to Lindi, where it is purchased by the Banyan merchants at about a quarter its value. Dr. Kirk has determined the plant which yields the best E. African rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly-made road from Dar-es-Salaam, in a W.-S.-W. direction, for about 100 miles towards the interior of E. Africa, through the Wazamaro country; it is apparently but little affected, except in the immediate neighbourhood of the villages, by the reckless mode of tapping employed. In many parts, a native can still collect 3 lb. of rubber daily. There are five species, but only one is considered worth tapping. Specimens received from him at Kew have been named *Landolphia florida* and *L. Kirkii*, the latter of which yields the best rubber. *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, E. Africa); at Magila, the rubber is made into balls for export. Dr. Kirk states that *L. owariensis* is common along the maritime region of E. Africa, and abundant at the mouth of the Zambesi, being found largely, at Shupanga on that river at 100 miles from the coast. The produce of this has been shipped from Quillimane for America. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in rubber with the tribes to the west. The district called Mungao, extending from S. lat. 9° 25′ to Delgado in 10° 41′, yielded 90,000*l.* worth of rubber in 1877, when the industry had been only 3 years in existence. In 1878, Kilwa and Mombasa added largely to the supply. On the Victoria Lake, are one or two kinds of tree producing rubber of good quality. Rubber plants grow on the slopes of the Cameroons mountains (W. Africa), but the

people do not yet know their value. Rubber trees abound on the river Djour in the province of Bahr el Ghazal.

The *Landolphia spp.* are principal among the rubber plants of W. Africa. The rubber is collected from *L. owariensis,* extending from 10° N. to 10° S. on the coast of W. Africa, and most abundant in the highland districts of Angola; *L. florida,* frequent in inner Angola up to 1,500-2,500 ft., and in Liberia; and *L. Heudelotii* in Senegal. According to Speke and Grant, the natives say that the best rubber is produced by *L. florida.* The plants of this genus are woody climbers, growing well in damp rocky ravines scarcely available for other culture. Being climbers, they could not be grown in separate plantations, but would probably flourish in any tropical jungle, where trees already existed for them to ascend. Every part of the stem exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies, and cut into small squares, which are then said to be boiled in water. According to other accounts, the natives cut off a piece of the bark, and the milky juice is allowed to run into holes in the ground, or upon leaves. In some districts, they simply let the juice trickle down their arms, going from tree to tree till sufficient has accumulated, then peeling it off from the elbow in the form of a tube. Elsewhere, it is said to be collected and left to inspissate in wooden vessels. Collins remarks that, if the incisions be allowed to penetrate too deeply, they liberate a gummy substance, which, mingling with the rubber, depreciates its value. These vines may be tapped for rubber when 3 years old. Christy suggests their cultivation in plantations, and annually cutting down the young shoots almost to the ground, then crushing the stems between rollers, and treating the whole mass with carbon bisulphide, which dissolves the rubber, but not (he says) the injurious gummy matter. The rubber of these vines is of fairly good quality when carefully prepared. It should be made in separate sheets or cakes, 1-2 in. thick and 6 in. or so in diameter. Iron or stone vessels are superior to clay for collecting the juice. The better kinds are said to be prepared with the addition of 3 per cent of strong liquor ammoniæ. When any liquid is added in the preparation, the sheets must be very thin, to facilitate drying. This question of drying seems to have much to do with the quality of the rubber, and the inferiority of African to Para rubber is largely attributed to its being sent into commerce in a raw, green state, whence possibly also arises its disagreeable odour, generated by decomposition. The desirability of introducing the *Attalea excelsa,* for the purpose of employing its nut (the *urucuri*) in curing African rubber, as in Para (see p. 1661), has even been discussed; but the slow smoky fire from any oily nut would probably have the same effect.

Another important W. African plant is *Urostigma Vogelii,* with possibly some other species. The tree (20-30 ft.) grows near the sea, at elevations of 50-60 ft., but does not flourish in marshy ground. The natives pollard the trees at 10-12 ft., and cut back the branches, thus obtaining a free and regular flow of sap. The cuttings are easily propagated, and grow vigorously. The trees are tapped at about 5 years, by making slashes or incisions in the trunk; the juice is collected in vessels, inspissated by the use of acids, and made up into balls the size of a large orange. Though often sent in a dirty state, the rubber is of good quality, and said to be the best of the Liberian. The juice obtained from trees less than 5 years old is watery, and does not afford such good rubber. Christy considers this a desirable species for cultivation in the lowlands of S. India, Ceylon, Java, Sumatra, Penang, and Siam.

A considerable proportion of W. African rubber is obtained from a plant which Holmes has determined to be *Tabernæmontana crassa.* In Senegambia, the *anjouan* (*Vahea senegalensis*) contributes to the supply. In Sierra Leone,

rubber is collected from *Ficus Brasii*; and some *Ficus spp.* yield it in Angola on the W. coast, and at Inhambane on the E. A specimen of rubber from the W. coast of Africa is attributed to an undescribed species of *Carpodinus*; and in Reunion, some is said to be derived from *Periploca græca.*

The rubbers sold under the general name of African, omitting Mozambique and Madagascar, occur as shapeless lumps ("knuckles") from the Congo; "negroheads" or "balls" of scrap, and smooth cakes, from Sierra Leone; "Thimbles," "nuts," and "negroheads" from the Portuguese ports; "tongues" from the Gaboon; and "balls" from Liberia. The African rubbers are more adhesive and less elastic than the Para article, and command a lower price; the inferiority could be much reduced by an improved system of preparation.

ASSAM, JAVA, PENANG, AND RANGOON.—Assam rubber is derived almost entirely from *Ficus elastica*, a small portion being obtained from *Urostigma laccifera.*

Ficus elastica grows wild along the foot and in the low tropical valleys of the Himalayas, from the Mechi River on the Nepal boundary at 88° E. long., to the extreme eastern limit of Assam, in 79° E. long, as well as along the feet and in the valleys of the southern mountains of the Bramaputra valley, viz, the Patkye, Naga, Khasi Jynteah, and Garrow Hills. It is not abundant until east of the Bor Nuddi, where it is common in the forests at the feet of the hills in the Khaling, Buri goma, and Kuriapara Duars, between the Bor Nuddi and Mura Dunsiri Nuddi; the rubber has been exported from these forests, which extend over about 40 sq. miles, as well as from the low valleys of the Bhutan Hills, immediately above them, and especially from the forests in the neighbourhood of the exit of the Nunai Nuddi in the Khaling Duar and the adjoining hills, and those between the Dimjany and the Ruta Nuddis. In the Chardwar forests, between the Mura Dunsiri or Ruta Nuddi and Borali River, the plant is abundant. Between the Bilsiri and Goboru Nuddis, it is found as far as 16 miles from the hills, but the drier climate renders the produce much less plentiful. In the Nowdwar forests, where the climate is less moist, only the rubber obtained from trees close to the hills is good. In the Chydwar forests, the trees are found only immediately along the foot of the hills. The plant may be seen in parts of Sikkim, in the moist but rocky side-valleys of the torrents that feed the Teesta and Mahanadi rivers. It is also very abundant in the moist forest of the northern rainy zone of Burma, beyond British territory. It flourishes best in a very moist climate and a mean temperature of 98° F. in the shade, but will not endure stagnant water about the roots.

The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced in the case of scattered trees. Immense forests of the trees existed on both banks of the Subansiri river, and on other streams, but the reckless treatment they received from native lessees of the forests caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. It is estimated that the forest of Cachar could yield upwards of 2,000 cwt. of rubber annually. One district in Assam, 30 miles by 8, is said to contain 43,000 trees, many of them being 100 ft. high. According to Murton, there is little doubt that this same plant, *Ficus elastica*, affords the *gutta-rambong* of the Malay Peninsula, produced in the interior of Perak and on the Patani side of the Peninsula.

The natives who tap the wild trees slash every part of them within reach with their *daos* or knives. The incisions on the lower part of the stem, and on the roots which run some 30-40 ft. on the ground, are 6-18 in. long, and are made diagonally through the bark and into the wood, in a elliptical form, measuring about 3 in. across the centre. The exudation from these wounds is received in holes dug in the earth, or in leaves folded conically; that from the smaller cuts on the upper branches is allowed to concrete on the spot. According to Collins, the yield of a tree in August is about 50 oz. of milk, giving 1[illegible] alls so low as 10 per

cent. He also observes that "during the cold season, October-March, the milk is scantier, but richer than in the warm weather, March-October." Mann finds the best tapping season in Assam to be February-April. Hunter states that the trees "yield most during the rains;" he adds that a high yield for the first tapping of a tree 18 in. 6 ft. in girth is 35-40 lb. of rubber, it is then allowed 3-4 years' rest, when a second but much smaller collection is made. Markham asserts that the trees may be tapped at 25 years, and that after 50 years they will yield 40 lb. of rubber every 3rd year. Murton says that in the Malay Peninsula the milk is obtained from the large roots, which are tapped 10-12 times in a year; a *picul* (133⅓ lb.) is sometimes taken from a large tree, but the usual yield is about ½ *picul*. This kind is said to require no preparation for market, and to present the appearance of long strings irregularly welded together, the best quality being gummy-looking, of very firm texture, and reddish-brown colour, while the inferior qualities have a large admixture of bark, and are much drier, without the gum-like consistence of the better grades. In Assam, on the other hand, it is the "loaf" rubber obtained from the lower parts of the stem and roots that requires artificial preparation, while none is bestowed upon the produce of the smaller branches. The treatment consists in pouring the milk into boiling water, and stirring until it assumes sufficient consistence to admit of being handled without becoming clammy or sticky. The plan adopted by a European house at Tezpore is to run the milk into wooden bins 6 ft. sq., partially filled with water, on which the rubber floats after a time. The latter, while still liquid, is removed and boiled over a slow fire in iron pans 4-6 ft. diam., and 2-2½ ft. deep, 2 parts of water being added, and the whole stirred constantly. When coagulated, the rubber is removed with iron forks, pressed, again boiled and pressed, sun-dried and washed over with lime.

The rapid destruction by the natives of the wild rubber trees in Assam has called forth efforts to establish their cultivation in regular plantations. That at Chardwar has an area of 80 sq. miles, some 700 acres being under cultivation already. In 1878, it was stated that the planting had scarcely emerged from the experimental stage, for though no doubt remained that the tree would grow luxuriantly in the locality chosen, there was much variation in the degree of success gained by the several methods of planting. The plants put out in cane baskets in the forks of trees, though alive and healthy, remained nearly stationary; and many of those simply planted in the ground also did badly, thus condemning these two plans. All those planted on low split stumps, in earthenware cylinders on low stumps of trees, on piles of wood put crossways and mixed with earth, and on small mounds of earth 2-3 ft. high, did remarkably well, drainage about the roots being ensured by these modes. It has been proved that the best cuttings do not transplant so well as seedlings, and that raising plants from seed will be the method of propagation to be chiefly depended on.

Assam rubber has a peculiar mottled appearance, and varies in colour from cream or flesh tints to bright pink or reddish; it is very glossy, and sometimes covered with a greyish-white film, which may arise from oxidation or from some foreign application. Its form is either that of irregular lumps ("slab" or "loaf") produced as already described, or "balls" of the unprepared stringy substance obtained from the smaller branches The impurities (bark, sand, clay) often reach 35 per cent especially in the "balls." It arrives in baskets made of split rattan, covered with gunny-sacking, and weighing, about 3 cwt. each.

Java rubber is also obtained from *Ficus elastica*, according to De Vrij. It is prepared by allowing the milk to concrete in the incisions made in the tree. It closely resembles Assam rubber, but has a deeper tint, with occasional reddish streaks.

Penang rubber is presumably identical in origin, no evidence being forthcoming in support of Wallich's statement that it is afforded by *Cynanchum ovalifolium*.

Rangoon rubber is also attributed to a *Ficus*, probably *F. hispida*.

These three kinds may be classed with Assam rubber for all technical purposes.

Attention has recently been called by G. W. Strettell to a troublesome climbing "weed," *Urceola* [*Chavannesia*] *esculenta*, very common in the Burmese forests, as a valuable source of rubber. It is urged that its cultivation could be made highly profitable. Assuming the plants to be placed 30 ft. apart, 400 acres would contain 19,200 of them, which are estimated to yield 1 *viss* (3 lb. 2 oz.) each per annum, worth 20*l.* per 100 *viss*, or 3840*l.* It is supposed that the cost of starting the plantation would be trifling, not exceeding 8*s.* per acre, per annum on the first 7 years, making a total for that period of 1,120*l.* The further cost of tapping, pressing, and preparing the juice is placed at 12½ per cent of the profits, leaving a net asset of over 3,000*l.* per annum. The milk is said to coagulate more readily than that of *Ficus spp.* The incision adopted by Strettell is arrow-like, and made on the sides of the stem. The rows of cuts are 3 ft. apart, and arranged to be in vertical lines. Funnels formed of the leaves of *Butea frondosa* are selected for catching the exudation. The best season for tapping is about the end of April; between October and March, circulation is slow and the milk is scarce, but during the rains, the milk is more watery and abundant.

Borneo.—The sources of Bornean rubber are not very accurately known. One authority names as the chief plant *Urceola elastica*, a climber with a trunk as thick as a man's body, and a soft thick bark, capable of being tapped at 3 years, and soon shooting up after having been cut down. Of this, Burbidge specifies 3 varieties, known respectively as *petabo*, yielding the best rubber, *menungan*, the most prolific, and *serapit*, giving the lowest quality. On the other hand, the *petabo* plant has been identified at Kew as a *Leuconotis sp.* Again Burbidge himself more recently writes that the Bornean rubber or *gutta-susu* is the mixed saps of 3 species of *Willughbeia*, with the milks of 2 or 3 other plants surreptitiously introduced to increase the quantity; and he gives the Malay names of the 3 species as *manungan*, *manungan puti*, and *manungan manga*. Their stems have a length of 50-100 ft., and a diameter rarely exceeding 6 in. He adds that they are being slowly but surely exterminated by the collectors in Borneo, as throughout the other Malay islands, and on the Peninsula, where they likewise abound; on the other hand, they grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation, and hence are especially deserving of the attention of the Government of India, where they may reasonably be expected to thrive. The stems of these creepers are cut down to facilitate the collection of the creamy sap, being divided into sections measuring a few inches to 2-3 ft. long; the escaping milk flows into jars or buckets, the exudation being sometimes hastened by applying heat to one end. When sufficient sap has been thus collected, it is coagulated into rough balls by the addition of salt water or nipa salt (the latter obtained by burning the foliage of the *nipa* or *susa* [*Nipa fruticans*]). It reaches Liverpool in porous or spongy balls and shapeless lumps, internally white or pinkish, and saturated with salt water in such quantity as to cause a loss of 20-50 per cent in weight on drying.

Burbidge remarks that there are many milk-yielding species of *Ficus* in the Bornean forests, which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the *Artocarpeæ* also deserve examination.

According to Murton, the *gutta-sing-garip* of the Malay Peninsula is identical with the *gutta-susu* of Borneo. There are two varieties of the plant producing it: one has a very dark-coloured outer bark, with lighter-coloured warts, and red inner bark; the other has a light cork-coloured outer bark, with longitudinal channels, and light-yellow inner bark. The produce of the former is considered superior. The stems are sometimes cut down, but are generally ringed at intervals of 10-12 in., and the milk is allowed to run into vessels made of palm-leaves or coconuts; the flow continues for some time, but after 10 minutes, the substance is very watery and thin. One plant will yield 5-10 *catties* (of 1⅓ lb.)

of coagulated rubber. When raw, the juice has the appearance of sour milk it is coagulated by the addition of salt or salt water, and resembles Bornean *Gutta-susu* in all respects.

Ceara.—The rubber known in commerce as "Ceara scrap" is produced by a distinct species from the other Brazilian and Central American rubbers, which has been named *Manihot Glaziovii.* It is a tree of 30 ft. in height, with a dense rounded crown, and attaining a diameter of 4-5 in. in 2 years. It grows wild in the flat country in the Brazil running inland from the coast-town of Ceara, in 4° S. lat., mostly, so far as is known, at an altitude of about 200 ft. The district possesses a very dry arid climate for a considerable portion of the year; the rainy season lasts from November to May-June, when torrents of rain fall for several days in succession, followed by fine weather. There are years when scarcely any rain falls. The daily temperature averages about 82°-90° F. The soil frequented by the tree is sandstone, gravel, or granite, its dryness and poverty being indicated by absence of all ferns, weeds, grasses, and mosses.

The native system of bleeding the trees and collecting the rubber is sufficiently simple. The collector commences by sweeping away loose stones and dust from around the foot of the tree, and spreading some large leaves to receive the milk as it flows from the tree. The outer surface of the bark of the trunk is then stripped off to a height of 4-5 ft., as shown in Fig. 1173,* and the milk exudes and runs down in many tortuous courses, a portion usually falling upon the ground. After several days the juice becomes dry and solid, when it is pulled off in strings and rolled up in balls, or put into bags in loose masses. The paring should only be deep enough to reach the milk-ducks, which reside in the middle layer of the bark; but this circumstance is seldom regarded by the collectors, and many trees are prematurely destroyed by the careless wounding of the wood. The operation is conducted only during the dry season.

The habits and habitat of this plant immediately pointed it out for cultivation in a systematic manner in some of our warmer possessions, and the success attending the experiments is the more desirable since the late drought in Brazil caused the death of immense numbers of the tree. It has proved itself to be well adapted for culture in Ceylon, Upper India, Zanzibar, and Jamaica, but the climate of the Malay Peninsula is too moist for it. The experience gained thus far in its cultivation may be briefly stated. Seeds are early produced, if the tree is not shaded. They should be buried in brown sand, and kept moist until there are indications of growth, when they may be planted out permanently. In some situations, where the ground is rough and strong, they might be sown broadcast. Plantations may also be formed by cuttings, which take root as easily as a willow. They should be from the points of strong shoots, and about 1 ft. in length. In planting, each cutting may be put down in the soil to a depth of 6 in. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all of which will grow if covered with ½ in., or so of soil. On loose sandy soils, or exhausted coffee land, plantations may be formed at little expense. Hard, dry, gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper, and a stout cutting put into each, and filled with pebbles. On bare or thinly covered portions of rock, the cuttings might be laid down flat, and a little heap of stones, or any kind of debris, about the size of a mole-hill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. Wherever there is any sort of stunted tree or shrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. There can be no doubt of the hardiness of the species, its readiness of culture, and adaptability to circumstances. It grows quite as readily from seed as from cuttings, and, though a native of a tropical sea-level, thrives well in Ceylon up to at least a level of 3,000 ft. and

* Those who want to see illustrations, can refer to page 1658 of Spon's "Encyclopœdia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

on the most barren soils. It would seem especially adapted for the dry and barren districts of the E. and N. provinces of Ceylon, or in the higher districts; but it would not be wise to risk it in localities where the temperature is liable to fall below 60° F.

The seed-coat is of remarkable thickness, and very hard, and the natural process of germination occupies, it is said, more than a year. All that is necessary to hasten this, is to assist the seed-coat in splitting, which is best effected by holding the seed firmly, and rasping off with a file both edges at the radicular end, recognized externally by possessing at its side a flat two-lobed appendage, technically known as the caruncle. It is best not to file off the actual end, as the radicle of the embryo may then be injured. After this treatment, properly performed, the young plant appears above ground in 2-3 weeks. The seedlings require no particular attention. They grow rapidly, and may be finally planted out at distances of 20 ft. The trees at Peradeniya (Ceylon) flowered at the age of 18 months; at 2½ years, the larger ones formed branching trees about 25-30 ft. high, with a stem 1 ft. 9 in. in circumference, at a yard from the base, and a smooth, silvery, birch-like bark, readily peeling off. The best system of tapping the trees under cultivation has yet to be proved. Some improved methods are described later on in the present article (see p. 1666).

This rubber is considered almost next to Para in value, being dry, very elastic, and free from stickiness; its one drawback of containing wood and other foreign matters, in such quantity as to cause a loss of often 25 per cent in washing, may doubtless be altogether removed by the exercise of care in the collecting.

Central American.—The Central American, Cartagena, and Guayaquil rubbers are yielded chiefly by the *ule*, (*Castilloa elastica*), a lofty tree with a trunk 8 ft. diam., found in Mexico, Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, Panama, the W. coast of S. America down to Guayaquil, and the slopes of Chimborazo, as well as in Cuba and Hayti. This extensive geographical range shows the tree to be capable of existing under considerably varied climatic conditions. The forests in which it grows are usually at or near sea-level, but it has been observed at an elevation of 1,500 ft. on the Pacific coast. The soil is various, but the tree avoids marshy or boggy land, and manifests a preference for warm, deep loam or sandy clay, and it especially affects the margins of small running streams, where it occurs in little groups. A moist climate and high equable temperature are essential; the trees thrive best in dense, steaming, hot forests, and are particularly abundant where it rains during 9 months of the year, and the temperature ranges between 75° and 88° F. A second smaller species, *C. Markhamia*, also occurs in Panama.

In Panama, the usual method of collecting the milk is by felling the tree, and then making deep notches around the trunk at distances of about 1 ft. apart, as shown in Fig. 1174.* Broad leaves placed beneath the notches receive the milk, which is afterwards collected in a large calabash or other vessel, poured into a hole in the ground, and thatched over with leaves, where it coagulates in about 2 weeks. Another plan is to bruise a handful of the leaves of the *Ipomœa bona nox*, and stir them about in the milk, which is thereby thickened in about an hour to a jelly-like porous mass, profusely exuding a black ink-like water when touched. The article thus produced is inferior. It is sometimes sliced into flakes 1 in. thick and sun-dried. In Nicaragua, it is found that though the tree yields the juice at all seasons, the best time for tapping is April, when the old leaves begin to fall and the new ones appear. During the rainy season, May-September, the richness of the juice diminishes. From that time till January, the rains decrease, the milk increases in richness, the tree prepares to flower, and the fruit appears in March, during which month

* Those who want to see illustrations can refer to p. 1,659 of Spon's "Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

and the succeeding one the milk contains the greatest proportion of rubber, the difference amounting to 60 per cent more in April than in October. A tree about 18 in. diam. (probobly 6 years old) tapped skilfully in April will yield some 20 gal. of milk capable of giving 50 lb. of rubber. This is a maximum figure, and the average is somewhat less. A tree of 20-30 ft. to the first branches is expected to afford 20 gal. of milk, and each gallon of milk to render 2 lb.-2 lb 2 oz. of good dried rubber. By the Panama system of destroying the tree, the produce often amounts to 100 lb. of rubber from a tree. The Nicaraguan mode of tapping is as follows. The collector ascends the tree by climbers or a ladder as high as possible, and then commences a series of incisions with a sharp *machete* or axe in one of two ways. One is to make a long vertical cut, with diagonal cuts running into it, as in Brazil; the other is by encircling the tree with spiral cuts at an inclination of 45°; if the tree be large, two such spirals are made, either crossing or paralled with each other. At the bottom of the trunk, and iron spout is driven in, and the milk is received into iron pails. In the evening, the milk is freed from foreign matters by passage through a sieve, before transference to the barrels in which it undergoes coagulation. This last condition is brought about by the addition of plant-juices, notably that of the *achete* (*Ipomœa bona nox*), as in Panama. The plant is collected, moistened with water, and bruised, and the juice, after straining, is added to the milk, in the proportion of 1 pint to 1 gal. After this operation, the rubber appears as a soft mass floating in a brown fluid, and smelling like new cheese. The mass is pressed under a plank or iron roller into a *tortilla* or cake, usually weighing about 2 lb. when dry, and representing 1 gal. of milk. When the *achete* or other suitable plant is not procurable, water in the proportion of 2 to 1 is added to the milk, and the whole is allowed to stand for 12 hours. The residue which separates from the water is poured into underground vats and left to dry for 12-14 days. Sometimes the milk is simply poured on a prepared spot of ground, and the watery portion left to evaporate or disappear as it may; the rubber, when outwardly dry, is pressed to remove *bolsas* or bubbles of watery liquid. Slabs made in this way are sometimes called *meros*. The rubber which is allowed to dry in the iron spout conducting from the tree trunk is rolled into balls, and called *cabezza*; that which dries in the wounds on the tree is termed *bola* or *burucha*, and is esteemed in New York. The loss by drying (*merma*) is estimated at about 15 per cent. A recent traveller in Central America states that the *ule* tree "yields many gallons every 2 years;" but in Panama, the tree is totally destroyed in obtaining the milk, and elsewhere the tapping is said to be so injuriously done as to be little better than immediate destruction.

There are several commercial varieties of the rubber obtained from *Castilloa spp.* Cartagena rubber arrives from New Granada (Colombia) in black sheets ¼ in. thick, having a somewhat rough or "chewed" appearance, and more or less "tarry" or sticky. It also occurs in strips or scraps pressed together in bags. It loses about 35 per cent of its weight on drying. Guayaquil rubber comes from Ecuador in large flakes and lumps, the better quality being whitish coloured, while the inferior is porous and saturated with a fœtid black liquid. Its loss by washing sometimes reaches 40 per cent. This and the preceding kind go chiefly to America. Nicaragua rubber, which mostly reaches the same market, loses only 15 per cent by drying. The best of the Central American rubbers is that known as "W. Indian," not from its being produced in the W. Indies, but coming in steamers sailing thence. It consists of blocks which, in the first quality, are formed of thin separable sheets. and, in the second, of conglomerated "scraps" with fragments of bark. Honduras rubber is of good quality, and free from "tarry" matter. Guatemala rubber is one of the lowest and least regular kinds; the best specimens are whitish, while the "lower" are black and "tarry." This rubber arrives in sheets compacted together, whence a thick resinous fluid exudes on pressure; this fluid, on evaporation, leaves a hard resinous substance uneffected by steam.

The wasteful and destructive local methods of collecting the milk of this genus are causing its rapid extermination in the countries where it is indigenous. Attention has been directed to its naturalization in our tropical possessions, but though the plant is of rapid growth, it will scarcely thrive in regions that are not equally suited to the *Hevea spp.*, and its rubber is much ineferior. It has been introduced successfully in Ceylon, Singapore, and Perak. With regard to its culture, it may be observed that trees in good situations will produce seeds early, but these need to be planted without delay, as drying destroys their vitality. Flowering occurs in January, and the fruits ripen in April (in Brazil). Stout branches, cut into pieces, each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings 1 ft. long and furnished with buds, planted in the usual way, sooner develop strong plants. But the propagation of this tree is not reckoned so easy as that of the Ceara rubber (*manihot Glaziovii*). In setting out young plants, the petiole or leaf-stalk of the lowest or oldest leaf should be buried in the soil; this simple device ensures the immediate and vigorous growth of the plant, and a symmetrical stem. When the planting leaves much bare stem above ground, the growth is slow, the plant long remains "leggy," and never forms a good tree. The plant has the curious habit of dropping its young branches, which disarticulate by a regular joint, and leave a clean scar on the surface of the stem. It is believed that after 6 years, the trees might be judiciously bled every 3 years.

Para.—Para rubber, which is second to none in importance, is afforded by several species of *Hevea* [*Siphonia*], the most important being *H. brasiliensis*, *H. guianensis*, and *H. Spruceana*. These trees inhabit the dense, steaming forests on the Amazon and its tributaries, other species replacing them in some of the adjacent countries, e. g. *H. paucifolia* in British Guiana, where Prestoe believes it will be found in considerable abundance. Brazil is being gradually but surely denuded of its rubber-trees, collectors being now driven to the Tocantins, Madeira, Purus, and Negro rivers in search of supplies. A recent traveller states that, in Bolivia, extensive rubber forests are at present profitably worked on the Lower Beni, and it is natural to suppose that they exist to an equal extent on the Mayutata and Aquiry; those on the Mamore and Lower Itenez, though giving rubber of a superior quality, do so in less quantity.

In the Para district of the Lower Amazon, the temperature varies between 74° and 95° F., the mean of the year being 81° F.; the supply of moisture is also very regular. On the Upper Amazon, the atmosphere is densely vapour-laden. The soil frequented by these trees is extremely rich mould. The trees will grow on the *terra firme* when planted, but their seeds naturally lodge in lowland swamps. All the species flourish best on rich alluvial clay slopes by the side of running water, where there is a certain amount of drainage; those growing on land which is periodically inundated (even to a depth of 5 ft.) are more prolific than those on very low or on elevated ground.

The methods adopted for tapping the trees are described at length by Cross. The collectors begin work immediately at daybreak, or as soon as they can see to move about among the trees. Rain often falls about 2-3 o'clock in the afternoon, so the tapping must be done early, as in the event of a shower, the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a certain number (3-12) of small cups of burnt clay. On proceeding to his work, the collector takes with him a small axe for tapping, and a wicker basket containing a good sized ball of well-wrought clay. He usually has likewise a bag for the waste droppings of rubber and for what may adhere to the bottoms of the cups, these promiscuous gatherings being termed *sernamby*, and forming the "negrohead" of the English market. The cups are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily, when, with a small portion of clay, they are pressed against the trunk of the tree. The contents of 15 cups make about 1 pint. Arriving at a tree, the collector takes the axe in his right hand, and, striking in an upward direction

as high as he can reach, makes a deep upward sloping cut across the trunk, which always goes through the bark, and penetrates 1 in. or more into the wood. The cut is 1 in. in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down, he takes a cup, and pasting a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time, the milk, which is of dazzling whiteness, is beginning to exude; if requisite, he smooths the clay so that the milk may trickle directly into the cup. At a distance of 4-5 in., but at the same height, another cup is luted on; and so the process is continued, until a row of cups encircle the tree at a height of about 6 ft. from the ground. Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by 9-10 o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours, or perhaps longer. The quantity of milk that flows from each cut varies; but if the tree is large and has not been much tapped, the majority of the cups will be more than half-full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapo* (inundated land) or on dry land, many of the cups will be found to contain only about a tablespoonful of milk, and sometimes hardly that. On the following morning, the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made 6-8 in. lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower, until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from the tree is great, two rows of cups are put on at once, the one as high as can be reached, and the other at the surface, of the ground; in the course of working, the upper row descending daily 6-8 in., while the lower one ascends the same distance, the rows in a few days come together. When the produce of milk diminishes in long-wrought trees two or three cups are put on various parts of the trunk, where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of over-tapping, as some have stated. Indeed, Cross believes it impossible to overtap a tree, if, in the operation, the wood is not left bare or injured. But at every stroke, the collector's axe enters the wood, and the energies of the tree are required in forming new layers to cover those mumerous wounds. It has been supposed that the quality of the milk is better in the dry season than during the rains. In the rainy season, the milk probably contains a greater proportion of water; but, on the other hand, a larger quantity of milk then flows from the tree. No doubt the dry season is the most suitable for rubber collecting, although, wherever a plantation is provided with a preparing-house, convenient tapping may certainly be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. Even if this were found to be true, it would probably make little difference, as tapping must be carried on when circumstances are most favourable.

There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and its tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree is cleaned off to a height of about 3 ft. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half or the entire circumference. Cuts are thickly made in the bark above this, from which, the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by winding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk may escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of "negrohead," the

result of the distance the milk has to run, and of the large quantity of clay employed in the process. The respective methods are illustrated in Figs. 1,175, 1,176, 1,177. Fig. 1,178 shows the exhausted tree in a state of decay.*

Going from tree to tree, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup, he draws his thumb or forefinger over the bottom to clean out some which otherwise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off, and classed as *sernamby*. The cups, on being emptied are laid in a little heap at the base of each tree, to be ready for the following morning. The trees occur at various distances (10-100 yd.) apart, and it is surprising that the natives have not yet seen the advantages that would be derived from forming plantations, whereby more than twice the quantity of rubber might be collected in one-fourth the time, and at far less cost and labour.

The common method of preparing the rubber is represented in Fig. 1,179.* The jars *a* are 18 in. high, and the bottoms are broken out. At the base, they are 7 in. diam., bulging out in the middle to 12 in., and narrowed at the mouth to a breadth of 2 in. Where a number of men are collecting for one master, much larger jars are in use. The milk, on being put into a large flat earthen vessel *b* is placed on the floor in a convenient position. Adjacent thereto, the jar is set on three small stones, which raise it to 1½ in. above the floor. The narrow space between the base of the jar and the floor allows the entry of air, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts (preferably *urucuri* [*Attalea excelsa*], but failing them, those of *Euterpe edulis* and other palms), are put on, then some more wood and nuts alternately. The latter are dropped in at the mouth of the jar, until it is filled to within 4 in. of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould *c* on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon, this is the article most frequently used, if there is much milk, and the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish, until the drops fall, then quickly places the flat side 2 in. above the jar mouth, and moves it swiftly round, as if describing the form of a cipher, with his hand, so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk on the mould, on being held over the smoke, immediately assumes a yellowish tinge, and although it appears to be firm on being touched, is yet found to be soft and juicy, like newly-curdled cheese, and to be sweating water profusely. When layer after layer has been repeated, and the mass ("biscuit") is of sufficient thickness, it is laid down on a board to solidify; in the morning, it is cut open along the edge on one side, and the mould is taken out. "Biscuit" rubber, when fresh, is often 4-5 in. thick. On being hung up to try for a few days, it is sent to market. The rapid coagulation of the milk seems to be simply produced by the high temperature (about 180° F.) of the smoke. Cross thinks that with a strong current of heated air, or a good pressure of steam from a pipe, or by putting the milk in shallow vessels, and evaporating the moisture by the heat of boiling water, a similar result would be obtained. The finely divided particles of soot which form a large proportion of the smoke undoubtedly absorb a considerable amount of moisture, although at the same time forming an impurity.

* Those who want to see ilustration can refer to pp. 1622 and 1623 of Spon's "Encyclopœdia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

A more modern method of preparing the milk is by treatment with an aqueous solution of alum, and subjecting the coagulated mass to pressure, in accordance with Strauss' proposition. This plan is said to be in favour, as being capable of performance at a distance from the unhealthy locality where the milk is produced. The proportion of alum solution required is very small, but varies with the character of the milk. The latter should be previously strained free from extraneous matters. Coagulation ensues in 2-3 minutes. The rubber is then exposed to the air on sticks, and allowed to drain for 8 days. It is sometimes subjected to expression. The drawback of the process is the "wetness" which the rubber acquires from the presence of saline particles, which are never completely removed by pressing.

The excellent quality of this rubber has commended the plant to the attention of agriculturists in India and elsewhere. The result of experiments hitherto seems to be favourable to its establishment in Ceylon, Malabar, S. Burma, Zanzibar, and Jamaica, but not in Central and N. India.

The propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green-coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within 3 in. of the plant. The portion above ground should rest on the earth on one side of its termination, so as not to suffer during hot sunshine. In all stages, the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open blaces, in the richest dark loam capable of producing a luxuriant rank crop of sugar-cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting a handful of wood-ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly felled piece of forest. If the wood is allowed to rot before burning, almost the whole of the fertilizing principal will be found to have vanished. If stored in a damp place, the value of the product is diminished. For planting on inundated lands, the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower end of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and, wading into the water, would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than 3-4 in. is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves.

Para rubber occurs in commerce in two forms:—"biscuits," prepared as described on pp. 1622-3, containing about 15 per cent of water; and rounded balls of "negrohead," containing 25-35 per cent of woody fragments, and other impurities. Occasionally an intermediate quality called "entrefine" appears. Adulteration is sometimes practised by the addition of the juice of the cow-tree or *massaranduba* (*Mimusops elata*).

PERNAMBUCO OR MANGABEIRA.—The *mangaba*, *mangaberia*, or *mangabiba* tree (*Hancornia speciosa*,), a native of the high plateaux of S. America, between 10° and 12° S. lat., at 3000-5000 ft. elevation, affords a kind of rubber. The inhabitants of Pernambuco, are now developing the supply of this article, which is collected by making oblique cuts penetrating the bark round the trunk, and

attaching receptacles thereto. The juice is coagulated by Strauss' method (see above), and after 30 days' drying, is sent to market in cases and barrels. It occurs in the form of "biscuits" and "sheets." Like all rubber coagulated by saline solutions, it is very "wet," and does not rank high in value. It may be remarked that these trees do not seem to have suffered from the recent droughts in Brazil. Further, that the rubber might me much improved in quality by a better method of preparation.

OTHER RUBBERS.—There are a few other rubbers which are prepared as articles of commerce, but as yet scarcely known in British markets. "Palay" rubber is obtained from *Cryptostegia grandiflora*, a common plant on the coast of India. In Chittagong, it is furnished by *Willughbeia edulis* and *W. martabanica*. Sumatran rubber is yielded by *W. prima*, and is exported to Holland. Malacca rubber is ascribed to *Urceola elastica*. The rubber of the Malay Archipelago is attributed to *Alstonia costulata* and *A. scholaris*; and Fijian rubber is produced by *A. plumosa*. In N. Australia, rubber has been procured from *Ficus macrophylla* and *F. rubiginosa*; the latter is hardy, and has been recommended for culture.

Many other plants afford juices which coagulate on exposure, and bear more or less general resemblance to indiarubber. They may possibly be utilized when better known. They are chiefly as follows:—*Ficus anthelmintica*, the *cuaxinduba* of Brazil; *F. Doliaria*, the *copaub-ucu* of Brazil; *F. elliptica*, of S. America; *Cecropia peltata*, of Tropical America; *Artocarpus incisa*, the bread-fruit tree, in Malaysia and Oceania; *Galactodendron* [*Brosmium*] *utile*, in S. America, especially Venezuela; *Lactaria calocarpa* and *L. Moorei*, of New South Wales and Queensland; *Tabernæmontana spp.*, in New South Wales, Queensland, and Malaysia; *Plumaria phagædanica*, the *sucuuba* of Para (Brazil); *Cameraria latifolia*, in Cuba; *Gymnema lactiferum*, of Ceylon; *Chrysophyllum spp.*, of Brazil; *Sideroxylon spp.*, of Malaysia; *Kakosmanthus macrophyllus*, of Java; *Imbricaria coriacea*, of Mauritius, Madagascar, and Java, *Ceratophorus spp.*, of Malaysia; *Macaranga tomentosa*, of the E. Indies; *Sapium scoparium*, of the Antilles; *Hippomane Mancinella*, of Tropical America; *Euphorbia corollata*, in Canada.

Commerce.—The commerce in rubbers, which may be said to be a growth of the last 25 years, has now attained great importance. Our imports of India-rubber (termed "caoutchouc" in the Returns) were 158,692 cwt., value 1,536,660*l.*, in 1876; 159,723 cwt., 1,484,794*l.*, in 1877; 149,724 cwt., 1,313,209*l.*, in 1878; 150,601 cwt., 1,626,290*l.*, in 1879; 169,587 cwt., 2,387,947*l.*, in 1880. The imports of 1880 were contributed as follows:—Brazil, 76,466 cwt., 1,297,373*l.*; W. Coast Africa, foreign, 22,922 cwt., 276,741*l*; Straits Settlements, 11,582 cwt., 114,989*l.*; Bengal and Burma, 10,264 cwt., 114,416*l.*; E. Coast Africa, 9,382 cwt., 129,886*l*; W. Coast Africa, British, 7,271 cwt., 86,669*l.*; Aden, 6,720 cwt., 84,780*l.*; British S. Africa, 4,620 cwt., 42,653*l.*; Portugal, 3,871 cwt., 55,804*l.*; United States, 3,799 cwt., 48,039*l.*; Central America, 2,440 cwt., 29,005*l.*; Holland, 1,576 cwt., 17,269*l.*; Mauritius, 1,550 cwt., 19,927*l.*; New Granada, (Colombia), 1,024 cwt., 12,165*l.*; other countries, 6,100 cwt., 58,251*l.*; total, 169,587 cwt., 2,387,947*l.* Our exports in 1880 were as follows:—United States, 21,941 cwt., 282,894*l.*; Germany, 18,921 cwt., 269,086*l.*; Russia, 16,189 cwt., 261,252*l.*; France, 9,920 cwt., 112,597*l.*; Holland, 7,182 cwt., 101,068*l.*; other countries, 2,579 cwt., 36,878*l.*; total, 76,732 cwt., 1,063,775*l.*

A review of the fluctuations in the supplies during the past 5 years shows the following facts. Holland sent us 2,651 cwt. in 1876, 1,059 in 1878, and 1,576 in 1880. Portugal: 3,329 in 1877, 2,285 in 1879, 3,871 in 1880. Portuguese W. Africa: 3,881 in 1877, 1,822 in 1878, 5,248 in 1880. Portuguese E. Africa: 617 in 1876, 131 in 1877, 1,497 in 1880. Fernando Po: 241 in 1876, 52 in 1877, 277 in 1878, 117 in 1879, 248 in 1880. W. Coast Africa: 16,841 in 1876, 9,632 in 1878, 17,426 in 1880. E. Africa (native states): 1263 in 1876, 7,855 in 1880. Madagascar: 32 in 1876, 83 in 1877, nil in 1878, 110 in 1879, 501 in 1880. Borneo: 15 in 1876, none since direct. Central America: 5,425 in 1876, gradually falling to 2,440 in 1880. Mexico: 62 in 1876, 291 in 1878, 50 in 1880. New Granada (Colombia): 3,398 in 1876, gradually falling to 1,024 in

1880. Venezuela: 521 in 1876, 354 in 1877, 710 in 1878, 482 in 1879, 986 in 1880. Brazil: 80,828 in 1876, 90,917 in 1878, 76,466 in 1880. Gambia and Sierra Leone: 2,827 in 1876, 5,641 in 1877, 3,808 in 1879, 7,104 in 1880. Gold Coast: 585 in 1876, 12 in 1879, 167 in 1880. Cape: 774 in 1876, 2,120 in 1877, 1,431 in 1878, 4,620 in 1880. Aden: 2,494 in 1876, 1,254 in 1878, 6,720 in 1880. Mauritius: 1,790 in 1876, 570 in 1879, 1,550 in 1880. Bengal and Burma: 12,990 in 1876, 9,260 in 1878, 10,264 in 1880. Straits Settlements: 7,615 in 1876, 5,436 in 1878, 11,582 in 1880.

The exports of Bornean rubbers are included under guttapercha (pp. 1653-4). Of Brazilian ports, Ceara, in 1878, sent 40,377 *kilo.* to England, 258 to Hamburg, and 74 to Havre. Panama (in Colombia) sent 23,128*l.* worth of rubber to the United States in 1879. Costa Rica exported 27,854 lb of rubber in the year ending Apr. 30, 1879; the quantities in previous years had been 57,213 in 1875, 59,427 in 1876, 90,576 in 1877, 78,231 in 1878; the shipments from the port of San José in 1880 were 11½ tons, 2,078*l.* Ecuador exported 7,059 *quintals*, value 24,707*l.*, in 1877; 6,561 *quintals*, 22,963*l.*, in 1878 (of which, 5,853 went to the United States, and 708 to England); 5,594 *quintals*, 33,564*l.*, in 1879; 7,995 *quintals*, 59,972*l.*, in 1880; in 1873, the exports were 16,365 *quintals*. Guatemala, in 1879, exported 1873 lb. to Belize; the value was 262 dol.; in 1877, the value was 2,723 dol. The exports from British India were 15,893 cwt., 108,645*l.*, in 1875; 15,258 cwt., 97,861., in 1876; 13,308 cwt., 90,169*l.*, in 1877; 13,794 cwt., 89,381*l.*, in 1878; 10,033 cwt., 61,685*l.*, in 1879. The exports from the Lakhimpur districts in 1871 were 260 tons, value 8,340*l.* Assam exported 11,000 *maunds* (of 82 lb. in 1873, and Sikkim 700. The exports from Java were 704 *piculs* (of 135½ lb. for the 1876 crop; 15 to Holland and 10 to Singapore for the 1877 crop; 47 to Holland and 15 to Singapore for the 1878 crop; 135 to Holland and 58 to Singapore for the 1879 crop. The values of exports of rubber from Madagascar to Mauritius have been 37,458*l.* in 1873, 21,452*l.* in 1874, 14,539*l.* in 1875, 9770*l.* in 1876, 4,672*l.* in 1877. The Venezuelan exports were 2,545 lb in British vessels, and 53,403 lb. in American, in 1878; and 27,563 lb. in American vessels in 1879. Mozambique exported 443*l.* worth in 1873 22,198*l.* in 1876, and over 50,000*l.* in 1879; the figures have now probably reached their maximum, until roads shall have been made into the interior.

Values.—The approximate relative market values of the principal commercial rubbers entering London are as follows:—Para, fine, 2-3*s.* a lb.; negrohead, 1*s.* 6*d.*-2*s* 6*d.* Central American, 1*s.* 6*d.*-2*s.* 6*d.* Assam and Pegu, 9d,-2*s.* 6*d.* Other E. Indian, 1*s.*-2*s.* 6*d.* Madagascar and Mazambique, 1*s.* 3*d.*-2*s.* 8*d.*

Suggested Improvements in Collecting and preparing Rubbers.—The time of year at which the sap ascends to the flowers as an effect on the quantity of rubber yielded. Too frequent tapping causes each successive yield to be less rich in rubber and more watery, and permanently injures the trees. Judicious tapping has no ill result. As to the manner in which the tapping should be performed, this will vary somewhat according to circumstances. Some remarks on tapping and barking other kinds of tree will be found under Cinchona (see Drugs, p. 803), manna (see Drugs, p. 817), and maple-sugar (see Sugar); also under Copaiba, Gurjun, Peru, Tolu, Turpentines, and Varnishes, in the present article. The Brazilian plan of a perpendicular incision, with oblique tributary cuts on each side, has much to recommend it. Paring the bark, after the Ceara method, might also be advisable. The one great object to be kept in view is the avoidance of injury to the cambium layer. This is best effected by using an implement which is so made that it can only just remove or penetrate the bark sufficiently deep to reach the laticiferous vessels, residing mostly in the *mesophlœum* or middle layer of the bark. A modification of the knife used in marking standing timber, with the addition of a shoulder to adjust the amount of penetration, and a long handle, would probably meet all requirements. A clean cut, as opposed to a ragged one, not only heals readily, but keeps the product free from woody impurity.

The collected milk should be coagulated as rapidly as possible, for decomposition soon sets in, and materially modifies the character of the article. Some of the milks keep much longer than others without undergoing great change, but the collection of the day would always be best dealt with during the same day. It is undoubted that an effectual evaporative process for removing the water will produce a better article than any of the saline solution methods. A convenient form for the prepared rubber is thin (1-2 in.) sheets, which are easily packed into bales, and enable the amount of impurity to be readily arrived at.

CAOUTCHOUC OF THE AMAZONE RIVER.

(*Translated from "Reveue Francaise" for "Ceylon Observer."*)

(Notes taken from Mr. M. Coudreau's pamphlet, published by the Société de Géographie Commerciale. For details refer to the publication of that Society, pages 131 to 135).

The principal product of the Amazone district is caoutchouc, an elastic gum (Indiarubber) made of the sap of a tree of the Euphorbium (?) family: the Indians have called it cau-uchu which we have changed into caoutchouc. This product is almost a monopoly, divided amongst about ten firms, five of whom are without rivals. Two or three commission houses in the interior and above all the all-powerful firm Elias Jose Nunez da Silva & Co. decline to submit to the whims of the speculators. This firm has had up to over a million kilogrammes in store awaiting a price they had fixed and which they obtained thus at times even ruling the consuming markets.

The principal shippers of caoutchouc are the following firms:—

Sears & Co., Americans buying for account of American firms and shipping to the United States.

Samuel G. Pond & Co., shipping to their own firm at New York: Burdelt and Pond.

Gonealves Vianna & Co., established at Havre, (Vianna freres) shipping for account of United States, England and France.

E. Schramm & Co., Germans, buying for account of the large London firm, Heilberth Symmons.

Martins & Co., Portuguese shipping for their own account to the United States and England.

Amongst the other firms, the French house, Denis Cronan & Co. is noticeable, which directs the bulk of its shipments to London for account of a firm at that place. For shipping Indiarubber from Para, the French rank very much below the Americans and the English.

The superiority of the production of the Amazone district compared to other producing countries, as far as quantity and quality is concerned is proved by the statistics of England and the United States.

The prices of Indiarubber, which in 1877, were in January fr. 2·85 per lb. and in June fr. 2·75 for Amazone quality, were only fr. 2·40 in January and fr. 2·25 in June for Centre-American; for January 1881, Amazone was worth fr. 4·25, the other fr. 3; in June Amazone fr. 4·40, the other fr. 2·55.

During the period 1871 to 1881 the maximum was for Amazone fr. 5·25 in October 1879 against fr. 4·15 for Centre-American.

We leave aside the qualities of Madagascar, Zanzibar and other points in Africa, those of Borneo, Annam and other places in Asia, which appear in small quantities only in the United States. The only rival to Amazone India-rubber is the Centre-American kind. For 1883 Amazone rubber was fr. 5·60 and Centre-American fr. 4 in the United States markets.

For the English market the superiority of Amazone rubber is likewise well established.

THE RUBBER-TREE PLANTING INDUSTRY IN CEYLON IN 1887.

(From the *Ceylon Observer*, 25th Feb. 1887.)

The result of a considerable amount of inquiry into the present condition of the rubber industry in Ceylon has led us somewhat unwillingly to the conclusion that for a time at least, the pursuit may be considered to be in abeyance—if not altogether abandoned by the majority of the planters who were so keen about it a few years ago. There are, it is true, scattered over the island a great number of properties on which are now growing Indian rubber trees of various kinds, more especially the "Ceara" kind, and on the selected estates from which we have authentic returns we find an aggregate of 150 acres under this cultivation. But if every patch of rubber trees in the country were counted, a much greater area would be made up. Generally speaking the age of the trees under reference is from four to five years, and the growth would appear to be in nearly all cases satisfactory, say from 15 to 40 feet. From but one property is there any statement to the contrary, and here we find some five acres planted on poor soil at an elevation of only 30 feet above sea-level. The growth is reported "poor and scanty." The lowness of elevation in this case has probably but little to do with the unsatisfactory growth of the tree, as is evidenced by the flourishing condition of specimens in Colombo at even less elevation than 30 feet above sea-level. The experiments that have hitherto been attempted in extracting the gum from the trees have so far resulted in disappointment. There is, however, a general concensus of opinion that the trees on which these experiments have been tried are too young to produce satisfactory results. Should such be the case it only requires time to effect a cure, and if the rubber can be grown in otherwise unprofitable portions of ground it would be well to continue cultivation with a view to paying results at some future day. There are one or two points which must be taken into consideration in noticing the experiments which have been made in tapping the young trees. As a rule the test has been so much per cooly at so much value. It must not be lost sight of that coolies unaccustomed to any particular kind of work—no matter what it may be—cannot do nearly so much in a day when new to the employment as they will after a time when they have got their hands accustomed to it. Moreover, in a new industry like that under reference, the master is no more acquainted with the proper *modus operandi* than the cooly, and is unable to task the coolies employed in the work.

The cultivation should not be condemned off hand, because the coolies employed in collecting are unable at first attempts to bring in more than ¼ to ½ lb. of rubber. Methods, no doubt, would be discovered after a time of causing the cuts or punctures in the bark to bleed more freely, in the same way as the natives induce the spathes of the jaggery (kittool) to give out a greater amount of palm juice than they would by a simple cut with a knife.

Though we cannot but take into account the exaggerated tone which pervades the whole of a letter we append which a native firm has received from Java, we may without fear of being misled take it for granted that the tapping of old trees may without harm be carried on from day to day for some months at a time, a process which, so far as we can learn, has never been attempted in Ceylon,—probably for want of some older trees on which to experiment. The result mentioned from Java of 25 lb. per three-year old tree in five months we look upon as altogether apochryphal, though it might be credible did the experience refer to large forest trees like our own *Ficus Elastica*. The fact mentioned by one writer of his collecting the rubber from the abrasions caused by blows of a heavy stick on the bark of the Ceara tree remind one of the traditions of the old Royal College boys in Colombo who used to break the bark of the protruding and tortuous roots of the common indigenous trees and wind off the rubber as it exuded from the abrasions until they got elastic balls nearly the size of those ordinarily used for cricket. It has been urged with some show of plausibility that our local

Government should encourage the growth of this common wild India rubber on the otherwise profitless banks of the low-country rivers, in view of the possibility of its being able at some future date to issue licenses for the collection of the produce, or at any rate to create a value for land, which at present is altogether unproductive. One of the lessons learnt during the few years in which Ceara rubber has been established in the island, has caused an entire revolution in the make of rubber nurseries. When first introduced into the island the seeds were sold at so much a hundred—germinated seeds, or seeds with the ends filed to facilitate germination—and in spite of all precautions a very large proportion of the seeds were failures while in contradistinction to this experience the seeds of the Ceara falling naturally on the surface of the ground and left to their own sweet will, sprang up like weeds under the parent trees and became rather a nuisance than otherwise. Observation of this fact led nursery-makers to merely turn up and soften the soil, throwing the seed on the surface and just covering with dead leaves, and a sprinkling of soil sufficient to hide the seed from the direct rays of the sun. Under these conditions the seeds seldom fail to germinate quickly even after having been left for months, even years, without any special care being taken of them. Of the rubber creepers such as come under the variety *Landolphia*, we can get but little information from our planting correspondents: no results further than ascertaining the capability of a few localities for their growth have as yet been attainable, though we hope in a short time to be able to learn something more about them, especially from low, hot, moist districts. It is impossible to observe without regret the very prevalent disregard by the planters in Ceylon of what at one time, it was hoped would eventually prove a very lucrative industry, and the produce of which is becoming daily more valuable for a number of processes connected with electricity and telegraphy. The fact of the matter, no doubt, is that facilty of production and resulting profits were at first so grossly exaggerated, that when actual results were ascertained by experiment on a fairly large scale, the disappointment was correspondingly great—and with rather unusual precipitancy discredit was thrown upon the whole concern, and it is no longer thought worthy of being followed up by cultivation on a large scale. However, we still hope at some future day to be able to number rubber amongst our valuable exports, though we must confess that at the present time there is not much to lend encouragement to our aspirations. We need hardly say that however pleased we may all be to welcome the enterprising—though somewhat exaggerating—gentleman from Java,—see letter below—there is no chance of his receiving any remuneration for the time and trouble involved in a journey from Batavia to Ceylon for the purpose of teaching us the art of extracting the milk from the rubber tree.

We now proceed to reproduce some of the reports from different planting districts in the island, with which we have been favoured in answer to our enquiries, and first from Matale, we learn from the proprietor of Wiharagama estate as follows:—

Wiharagama estate has about 25 acres Ceara rubber and specimens of other varieties. Age seven to four years but principally four years old. No harvesting has been attempted as the trees for the most part are not considered old enough to tap without deterioration, and the older trees are not numerous enough to offer inducement for systematic tapping.

The Manager of Kandanuwara, in the same district, writes:—

Kandanuwara estate has nine acres or about 6,000 trees of Ceara India-rubber; growth in years equal five; in robust healthy condition and in a variety of soils. Milking was attempted in 1886 to the extent of about 20 lb and gave from ¼ to ½ lb per cooly, but my opinion is that at this early stage of its growth, whatever it may do later on, possibly nothing much greater, it does not pay to grow this variety for rubber. I am told Ceara rubber trees have been found suitable for cacao shade in Dumbara and I have planted cardamoms under them here, but have not found them by any means equal to the natural jungle shade.

We can vouch for the success of Ceara rubber shade for cacao in Dumbara, by what we saw on Pallekelly, where, we believe, Mr. Vollar has a high opinion

of the tree, both for its rapid growth and favourable shade. Mr. Vollar had also made some highly successful experiments in harvesting rubber, to judge by the quantity he was able to gather off individual trees without giving much attention to the matter. The rapid growth of the Ceara tree in the Dumbara valley is very remarkable.

From Mr. Charles Gibbon of the Panwila district we have the says following report, but Mr. Gibbon valuable results should be got during the present month:—

Goonambil estate has some 15 acres of India-rubber Harvesting, tapping has been attempted on two or three occasiona but the result as to quantity did not justify it being continued. The quality of rubber has been very good. Experiments will be made in January and February (which will be the best harvesting month probably,) and I will communicate them to you. Some of the trees are eight years old, but the larger proportion are half that age.

From Hantanne district, we learn that,—

Galoya estate has ten acres of Ceara trees of India rubber growth in years equal four years, but the cultivation has been abandoned and weeds allowed to grow. Some of the trees are very fine.

Farther south, we have reports as follows:—

Ambalawa, estate (in Dolosbage) has 30 to 40 acres of trees of India-rubber, growth in years equal from three to five years old; growth good. I have not tried any regular system of harvesting; have tapped several trees and found the quantity of rubber insufficient to pay cost of collecting.

Sanquhar estate, Pussellawa, has 11 acres clearing, and also about 500 trees planted here and there about the estate. The 11 acres is four years old having been planted in 1882, the other trees a year older. The trees in 11 acres are pretty regular, but have forked rather low. No harvesting has been done nor has any record been kept of any particular tree's growth.

Kanapediwatte estate, Pussellawa, has about three acres of India-rubber, three years old. No harvesting has been attempted owing to the failures of others in obtaining satisfactory results.

Our only report from the high districts, is from Mr. Mackie of Great Western, who wrote:—

We tried rubber-trees on the Rathnillokelly division of the group four years ago—elevation 4,000 to 4,200 ft.—only a few came up in the sheltered parts. Some are now 10 to 15 ft. high, but I cannot speak of them as a success. I do not know that the cultivation of this tree has been tried much above (say) Nawalapitiya on this side, at any rate I have not seen any save our own growing in this part of Dimbula.

Crossing to Uva, we learn from Mr. Hoseason that,—

Kottagodde estate has here and there trees of India-rubber, growth in four years, equal to 15 to 25 ft., but nothing has been done to them nor are they in any way cultivated, nor is any gum taken from them.

But the most complete report is that for which we are indebted to Mr. Philby of Cocoawatte estate, Lunugalla, as follows:—

Cocoawatte, 27th Nov. 1886.

To the Editor of the *Ceylon Observer*,

Dear Sir,—I now send you a few remarks on the cultivation of rubber on above estate.

Extent.—I have 30 acres of Ceara rubber planted from three to five years old; the growth appears to be satisfactory and there is no appearance of disease.

Wintering.—The trees winter regularly every year about June and July, as all the leaves drop off and the tree looks as if it was dead, but in a very short time the young buds appear and the foliage becomes as luxuriant as ever.

Seed.—About the third year the trees begin to flower and bear heavy crops of seed which drops on the ground when ripe and germinates readily.

Harvesting.—I have not yet arrived at any satisfactory process of extracting the rubber. I have succeeded in getting a quarter of a lb. per cooly but this will not pay. There is no doubt, that the rubber is there and the question is how to get it? Do the rubber gatherers of Brazil fell the trees before tapping them? From a tree which had been felled a fort night or more I got two ounces of rubber in about a quarter of an hour. Passing it in the morning I knocked it about with

a big stick and in the afternoon I found lumps of congealed milk where each blow had fallen and easily picked them off.

Enemies.—Pigs and porcupines are the chief enemies of the rubber tree and they are very fond of the potato-like bulbs at the end of the roots. However, they do not do much harm here and it takes a good deal to kill a rubber tree when once established.

I should very much like to know at what age it would be considered right to begin tapping and also any known process of extracting the rubber in paying quantities. I annex a table of measurements of trees from one to five years old, some are larger and some are smaller, but these figures represent a fair average of the growth on this estate.—Yours faithfully,

H. MONTAGUE PHILBY.

TABLE OF MEASUREMENTS OF RUBBER TREES.

1 Year Old.—18 feet high; 10 inches round base; 6½ inches round 6 feet from ground.

2 Years Old.—26 feet high; branched out 14 feet from ground; 22 inches round base; 14 inches round 6 feet above ground.

3 Years Old.—37 feet high; branched out 15 feet from ground; 30 inches round base; 24 inches round 6 feet from ground.

4 Years Old.—43 feet high; branched out 17 feet from ground; 42 inches round base; 25 inches round just under branches.

5 Years Old.—48 feet high; 45 inches round base; branched out 22 feet from ground; 33 inches round just under branches. H. M. P.

We are much obliged to Mr. Philby and think his trees on Cocoawatte must equal those we saw in Dumbara in size for age. As to the questions asked about Brazil and felling operations there, we shall have pleasure in sending Mr. Philby a copy of the second edition of our "Rubber Manual" now in the press, in which he will find the latest available information from all parts of the world. Tapping and also felling and stripping are both practised in South America.

We now turn to the lowcountry of the Western Province and from Kelani Valley we have the following:—

From Manager Mahalla, Muraloya and Dambuloya. Those estates have neither acres nor trees of India-rubber. I may mention that there are two or three in Mahalla and Muraloya, but nothing is being done to them.

Pleasure Ground estate has 500 trees (? creepers) of Landolphia Kirkiei India-rubber, equal four years' growth. These are kept as show trees and are very large, the largest was somewhat destroyed in cutting thick stem for "Indian and Colonial Exhibition.' They are being kept to see if they will seed. [But why not send us measurements?—ED. C. O.]

More satisfactory is the following report of his experience at Heneratgoda and Mirigama by Mr. W. B. Lamont:—

Having reared about 100 plants of Ceara rubber up to their fifth year and having given a good deal of attention to them, I arrived through a long course of experiments at the following practical results. One half of the plants turn out useless, either from the inferior quality or small quantity of their yield; that all such trees should be eliminated as soon as their character is ascertained, and replaced by others; that no satisfactory result will follow any attempt to obtain produce before the tree is at least four years old; that no system of cutting or piercing the bark will give a satisfactory yield; is that it only in the dry season, when the tree is leafless, and the growth at a stand, that a satisfactory result can be obtained, in the way of harvesting. The plan of obtaining the rubber, that my experiments led up to, was, as soon as the leaves begin to fall, remove the outer bark in vertical strips of not more than two inches wide, and not less than four inches apart. The tender inner bark thus exposed to the sun breaks out, in something like running sores, from which the rubber slowly exudes and drips on the surface as fast as discharged. In this process, the strip of exposed bark is destroyed, but a vigorous tree working from both sides will close in on the bared part in the course of the year, if the width is not more than two inches. Ceara rubber planted at 100 trees per acre will, after the second year, require hardly any expense in cultivation, and for the harvesting I collected 30lb. last January and February, by one boy at 15 cents a day, or say, 23 cents per

pound, the local value being about 80 cents. Supposing each tree equal to an average yield of one pound per annum, and allowing 30 cents for cultivation and collecting, 50 cents would remain as profit, or R50 per acre. It is well to have the plant in the island, but it is not likely to be largely planted so long as there are other products that pay better, or that are better understood, but a time may come when it will *kep a strait.*

"Fifty rupees an acre" is a return not to be despised: indeed we doubt if the average from coconuts for all cultivated plantations in the island is so good, and, therefore, there ought to be plenty of room for a systematic Ceara rubber industry in Ceylon; but what is the use of speaking of such returns as can be got here if we are to accept the statement ot a Java planter (already referred to) conveyed to us by Messrs. J. P. William & Bros. as follows:—

The Editors Ceylon Observer.

Dear Sirs,—Many planters from different countries had written us from time to time enquiring as to the best mode of tapping the Ceara Rubber tree, and we are glad to place before the planting community the following letter sent us by a Ceara Rubber planter in Java, dated 30th November 1886. We shall be happy to give the name and address of the planter in question to gentlemen who may be willing to communicate with him. Newspapers please copy,—Yours obediently.

J. P. William & Bros.,

New Product Growers, Seedsmen, &c.

7th Jan. 1887. Heneratgoda, Ceylon.

Letter referred to :—" From different papers I got the knowledge that the tapping of the Ceara Rubber tree (Manihot Glasioii) is very expensive and do not give much results. I now beg to inform you that by my manner of tapping even trees of nearly three years age by once carving, produce four till five ounces of guttah each, and this manipulation can be repeated every two days during five or six months without doing any harm to the carved tree, also supposing every tree is carved 15 days a month, about five months the production of every tree at the end of five months will be 300 ounces or 25 pounds. Besides that my manner is not expensive, and the production is of the first quality. If the different planters of the Ceara Rubber tree like to be acknowledged with my manner of tapping I am ready to go to Ceylon in order to show the manipulation if all costs of transport and staying will be paid by the planters, and a remuneration according to the number of trees of every plantation. As I do not know the planters of Ceara Rubber and their number at Ceylon I cannot apply to each of them directly, and therefore, call on your kind assistance in this affair being ready to part with you the remunerations the planters should like to give for my manner of carving and tapping the abovementioned trees. Hoping to be favoured with any answer of you."

Messrs. William Bros., had better tell their correspondent to patent his process for Ceylon and then come here and lease the Ceara rubber groves already fit for harvesting, while planting on his own account.

From the Southern Province we have two brief reports:—

Hurst-Pierpoint estate has five acres or 5,000 trees of India-rubber, equal four years old. Nothing has been done with them and no results can therefore be sent. Trees are growing on bad soil at an elevation of say 30 feet and are poor and scanty in growth.

In Udugama district Rubber cultivation has been dropped entirely. I asked some of the neighbours and no one seems to have carried on experiments since Mr. Dobree left the district, and I think he sent you the result and particulars of his experiment.

We trust the above recapitulation of the present stage of the Rubber Planting Industry in our midst will have one good effect, namely, in stirring up our planters to renewed interest in the subject, and to experiments with the trees already available.

WONDERFUL DISCOVERIES: INDIARUBBER IN WOUNDS.

The medical journals for the past ten years have given accounts of wonderful discoveries in surgical science, and of their application in practice—the filling of large, deep wounds with sponge, and the organization and assimilation of the latter; skin-grafting, bone-grafting, and the successful adjustment and regrowth of fingers. Recently two other wonderful discoveries have been reported. One is the organization of rubber within the animal tissues; the other, the organization of blood clots, their formation into new tissue, and the application of them to the surer and better healing of surgical wounds. As to the first, it appears that Professor Vanlair, of France, had, in a certain case, inserted a drainage-tube, of ordinary gray vulcanized rubber, one and one-fourth inches in length and one-fifth in diameter, and that this, at the end of seven months, seemed to have undergone partial absorption. But, on examining it with a microscope, it was found that the substance of the rubber had become truly organized; that the lower end of the tube had become fully assimilated to the surrounding tissue, and had wholly lost its original form; that the part of the tube next above this had lost its original shapeless appearance, and had acquired a complex structure, showing fine connecting tissue fibres with cells of various forms between them, and very numerous capillary blood-vessels.

Says the *Medical Record*:—"That Indiarubber can thus become organized is the more remarkable when we consider that it is a pure vegetable exudation, devoid of all structure, and seemingly more calculated to act as a foreign body and so prevent the union of the wounded surfaces, than to undergo organization to and become thus and integral part of the animal tissue."—*Companion.*

INDIARUBBER GATHERING.

During a twelve-month's stay on the river Purús, a tributary rising in the Bolivian Andes and falling into the Amazon on its right bank about 1,050 miles west of Para, I saw a deal of Indiarubber gatherers, and the way this important article of commerce is collected, and prepared for exportation.

The *Siphonia clastica*, or tree from which rubber is extracted, is found throughout the Valley of the Amazon, though the tributaries on the south shore of the great river between the Madeira in Brazil, and the Ucayali in Peru, yield the greatest supply. It grows upon the *vargems*, or lowlands annually submerged by rising streams, then called *ygapos*, or swamps. A full-grown tree usually attains a height of seventy feet, with a stem a little over two feet in diameter. Rubber trees found on lands one hundred feet above high-water mark are of no practical value, the yield of milk not compensating for cutting.

Let me introduce the reader to a rubber station called Terruhan, on the left bank of the Purús, about 900 miles from its mouth, and consequently nearly 2,000 miles from the Atlantic. Facing the stream is an open shed built upon piles of hard wood capable of resisting the white ant and the steaming humidity of the climate. The floor, about six feet from the ground, is composed of the half rounds of split *pashiuba* palms, laid an inch apart, and held down with vegetable twine. This gives plenty of ventilation from below, and considering the establishment has no walls, and that rain sometimes inconveniently percolates through the palm-leaf roof, no complaints can be lodged against the architect on the score of shutting out fresh air. Happily I had brought out the frame of a large square room, which I soon rigged up. A sheet of stout canvas was laid on the floor, and a strong kind of butter cloth stretched on the walls and roof enabled me to see everything outside, and enjoy comparative immunity from myriads of *pihums* by day, and mosquitoes by night, besides the importunities of vampire, bats, tarantulas, and snakes, *et hoc genera*, which sometimes persist upon making the personal acquaintance of visitors and natives.

My host was a thin, sickly Brazilian from Ceara. He called himself a *branco*, or white, and would have felt mightily indignant had anyone ventured to doubt his right to the title, but he was more Indian than white. He had left his sterile sandy province for the verdant forests of Amazonia, and, in the hope of making a fortune, had invested about £150 in prints, calicos, cutlery, beads, *farinha*, rum, guns, ammunition, and "notions" for barter. On his way up he enlisted a number of needy adventurers of every shade between ebony and copper, first of all priming them with glowing representations and promises, and fiery *cashaca*, or rum. Once on board, he kept all hands half-intoxicated until too far on the journey for them to think of venturing back alone. The party numbered fifty all told, including several Indian women called *Tapuyas*. Having reached a suitable spot named Terruhan, after an Indian village on the high land about a mile distant, a clearing was made facing the river, and a huge open hut erected for headquarters, whither all might resort during the rainy season with the produce of their labour. The party then broke up into twos and threes, to all of whom were apportioned an area of *vargem* land where rubber trees exist. Here rude shanties were constructed for shelter, and once a month the rubber cutters would paddle down to headquarters with the rubber collected, receiving on account a supply of rum, tobacco, rice, sugar, coffee, and *farinha*—the common substitute for bread throughout Amazonia. Every man had a Birmingham trade gun, and as the "location" was some hundreds of miles from the nearest own, no fresh animal food could be obtained beyond what was killed in the forests. Game was plentiful during the dry season, when it was nothing extraordinary for us to bag half a dozen pigs, besides a tapir, or so, in a single day's shooting. At such times we indulged in tremendous feeds, because it might be days before getting another. Fresh meat rots in twenty-four hours, so we cooked as much as our vessels would hold, the dogs and alligators making short work of whatever remained. Sometimes we managed to bring down a deer, and more than once I have been glad to dine off the arm or leg of a big black monkey called the *coaita*. I confess, however, to always having had qualms of conscience and stomach when devouring Mr. Darwin's friends. The *coaita* travels in bands of sixty or seventy. When they look down and chatter to each other, and monkey mothers cuddle puling babes in their arms, it requires downright hunger to knock one over. I remember upon one occasion, while dressing a big fellow for cooking, his appearance seemed to bear such a striking resemblance to Hamitic humanity that I could hardly bring my mind to further act as *chef*. But I was very hungry, and am prepared to say that I had no nightmare after supper. Small monkeys taste like hare. We found *jabuti*, a sort of land tortoise, passable food. Fish was plentiful when the river was low, and at such times we had *surubim pirarucu*—nearly as big as a good sized sturgeon—*tambaqui*, *piranhas*, and small flat fish—capital eating. Now and then we haunted turtle on sandy reaches, and obtained baskets full of eggs, the yolks of which were not bad when mixed with *farinha*. Turtle not required for immediate use were kept in a fenced pond. Sometimes we bagged wild turkeys, geese, *magoarys*, *ynambus*, *cujubim*, parrots, and macaws. The two latter require a deal of boiling, and unless decapitated when shot, retain a *catinga*, or unpleasant flavour. We had no vegetables, but forest fruits abound, and their judicious use is an admirable corrective; they prevent many ailments from which new-comers apparently cannot otherwise escape.

I will now describe, from notes in my journal, a day's rubber cutting and the method of preparing milk. Rose about 5·30, just before sunrise. Supped basin of coffee mixed with *farinha*, carefully loaded our guns and in company with Feliz, a brother of my host, started for a day's rubber cutting, Feliz carrying a small steel tomahawk and a two gallon tin-can strapped upon the shoulders. My guide was a wiry youth of eighteen, a keen hunter, a dead shot, a swift runner, and full of fun and humour. In the distance we heard a band of *guaribas*, or howling monkeys, giving a final chorus. They usually commence at sunset, and amuse themselves by uttering blood-curdling shrieks at

intervals till daybreak. Feliz says he believes they howl because of toothache. Countless birds now began to whistle, pipe, coo, and scream; *cicadas* kept up a deafening stridulation, and the rise and fall of insect hum and twitter resembled the distant roar of ocean surf. A gentle breeze rustling among tree tops brought down a smart shower of dew deposited during the night. Though drenched with perspiration and water—one always freely perspires asleep and awake in equatorial latitudes—we were sheltered from the already blistering rays which would soon impart to the forests the temperature of a Turkish bath.

The run was nearly two miles in length. When the Purus rises fifty feet, the land submerged on both banks will vary from a few yards to ten miles. I reckoned one rubber tree to about eighty others, and of these not half a dozen would belong to the same kind. Some, such as the *massaranduba*, or cow tree, were of stupendous dimensions, the lowest branches being as much as a hundred feet from the ground. These huge boles resembled vegetable towers, their gnarled, twisted roots stretching along the soil in serpentine convolutions. This tree yields a milk resembling the finest produce of the dairy; mixed with coffee it is both nutritious and agreeable. The *samauma*, or silk cotton tree, often attains a prodigious growth. *Assacus*, the upas of Amazonia, are frequently met with of vast size. Their thorny stems are usually covered with moss, and the milk exuding from an incision is said to be as deadly as strychnine. *Curuas*, a ground palm, with long narrow leaves drooping round the central spathe, resemble an emerald fountain. Millions of bush ropes hang from giddy heights: rare orchids flourish on lower branches; curious air plants dangle overhead: delicious scents indicate unseen flowers; foul exhalations rise from stagnant pools, and great blocks of woody fungus adhere to tree trunks. There is an almost infinite variety of palms. Some flourish best on the margins of stagnant lagoons, too foul even for alligators to live in; others prefer the edge of lakes and banks of rivers, while some are always found in openings where a monarch of the forest has tumbled to the earth, crushing down smaller trees in its fall. Here are the Hebes of these bosky solitudes, the *assai*, with bunches of purple fruit which make a delicious drink.

On *vargem* lands, I was struck with the number of young trees of about a foot in diameter which had been attacked by a vegetable parasite that strangles its victim by squeezing the stem so tightly that sap cannot ascend above its ruthless embraces. The parasite first runs up the trunk in the form of an almost transparent tendril. On attaining light and air above, it rapidly increases in girth, and then throws out tendrils at irregular intervals, which meet, entwine, and form solid rings, that in time contract with such terrific force as to make its victim bulge out above and below the embraces. As a rule, this is unavailing to burst the deadly grip, and by-and-by the tree threatens to fall. Apparently conscious of impending disaster, the parasite throws out tendrils which droop to the earth, take root, and form on elaborate system of struts by way of support. Long after the tree itself is dead and withered, its naked boughs are decked with a brilliant canopy of flowers and foliage. In time the roots give way, and then a sudden puff of wind hurls the parasite and its victim to the ground, where both decay to enrich the soil.

Insect life abounds in these regions. Almost every leaf is covered with ants, and thousands of air shafts spring up from *formicaria*, some of which latter are hundreds of yards across. It is hardly possible to put one's foot down without crushing some kind of insect. *Morpho* butterflies a span long float on azure wings about eight feet from the ground; huge beetles burrow in the soil; and here and there are snails, slowly dragging their length with shells on the back capable of holding a pint of water.

A rubber tree is first tapped six feet from the ground. The number of incisions made depends upon the diameter of the trunk, but one a foot thick will bear six. The first two rows of cuts are practically of no account, the yield being very watery; the lower the cuts the richer the milk. The incision is made by striking the edge of a small steel tomahawk deeply into the bark,

After this operation, my companion stuck a tin cup on to the bark with clay, into which milk immediately began to trickle. By the time our journey was finished one way, every tree had from three to eight cups adhering to the stem. This work would not be fatiguing in a temperate climate, but we were glad to sit down and rest awhile previous to hunting something for dinner.

We crossed a number of tapir tracks, the impressions on the soft soil showing the beasts must have weighed as much as an ox. We also saw *rastros* of deer and pigs, but for some time caught sight of nothing. Suddenly Feliz motioned me to stand still, and gliding away with a swift, stealthy step, he was soon lost to view. On a tree close by I observed a number of lines where a big jaguar had scratched like a cat to sharpen his claws; the bark was deeply indented. On this I peered among the branches overhead, for I had found jaguars to be nasty customers upon more than one occasion previously, and had no ambition to be caught napping. Unless killed or disabled by the first shot, they show determind fight, and the way they make for you indicates mischief. Presently I heard a sharp report, and then another, and then a "cooey," by which I knew someting had been bagged. Hurrying up, I found a good-sized porker in his last gasps. We immediately cut off the gland on the back just above the tail, which contains a secretion of sickening odour, and severing the fore and hind quarters, left the rest, and retraced our steps homewards, Feliz emptying the cups of milk into the can on his back. The incisions were already closed up with coagulated milk, but this was cleared off and stopped with clay.

It was past noon when we returned to the hut, nnd after a welcome meal, we were glad to tumble into our hammocks aud have a couple of hours' snooze before resuming work. The rubber milk had now to be smoked, and this is how it was done. First of all a few dry stieks were set on fire, and on these were piled *urucari* palm nuts, the whole being covered with a bell-shaped earthenware dome or oven, with a narrow opening at the top, from which curled a dense white smoke of pungent smell. A saucer-shaped calabash was now dipped into the can of milk and poured over a canoe paddle blade, which was then slowly turned round in the smoke until the milk had coagulated. This operation was continued until every drop of milk had been used, and day after day the same process resumed, until the ball became too heavy to turn, when one end of it was cut and the paddle withdrawn. In three months' time the ball shrinks to a little over half its original size.

A diligent workman—no skilled labour is required—on a good run, can easily earn 20s. per diem during six months of the year. The ignorant negroes and half Indians, however, who are engaged in this labour, are obliged to hand over their rubber to the trader who supplies them with goods. These are fixed at a most exorbitant price, and as the rubber cutter is rarely able to read or write, the books are usually against him, and he is kept in semi-slavery to an unscrupulous trader who soon grows rich and retires, selling his book debts to another, who gives unlimited rum and feasting for a week, when he continues the devices of his predecessor.

Some traders send down to Para thirty or forty tons of rubber in a single season. Gangs of sharpers are always on the look-out for successful traders, and it not unfrequently happens that gains amassed by cruel employers are in turn lost at cards. Indeed, steam-boats plying on the Amazon are notorious gambling dens, and a voyage rarely takes place up and down the river between Para and Manaos on the Rio Negro, a distance of 1,000 miles, without one or more traders coming to grief.

During the wet season, heavy thunderstorms take place every day when the warm rain descends in torrents and renders rubber cutting impracticable. This is the hotter season of the two, clouded skies, shutting out cool air, and rendering the afternoon and evening little short of stifling. As the great tributaries of the Amazon rise, fish wander from them to feed on flooded lands, and are difficult to catch. Game, too, leave for high lands, and fewer birds are seen.

During this season, even the alligators have a hard time of it, and the scaly monsters skulk about human dwellings to pick up what can be had. Like tigers, they certainly prefer dog's flesh to any other, but women and children are sometimes carried off. Insect pests increase in number and voracity, and what with heat, hunger, malaria, and mosquitoes, life is hardly endurable. The poor rubber cutters are often put to great straits for fresh food, and all hail with delight the fall of the river, which means abundance of food and renewed opportunity for work.

R. STEWART CLOUGH.

[The foregoing article is reprinted from *The Welcome* by kind permission of S. W. Partridge & Co.]—*Indiarubber and Guttapercha Journal.*

LAST YEAR'S RUBBER TRADE STATISTICS.

We are now enable—so far as the monthly Board of Trade returns permit—to obtain some idea of the position of the rubber trade during 1885; but complete and finally revised statistics indicative of the sources from which imports were drawn, and of the countries to which exports were sent, will not be available before July or August next. On another page we give the figures of rubber imports and exports during the twelve months of 1885, and they are well worthy of study. The broad fact, which first claims consideration, is the decreasing value of total rubber trade of the United Kingdom—imports and exports taken together—which, in 1885, amounted to £4,224,099, as against £4,946,528 in 1884, and £6,704,379 in 1883!

These figures are startling and unsatisfactory enough, but when analysed further they are not less so. The imports, which were considerably in excess of the exports, even when "home consumption" is allowed for, reached a total value of £2,323,762 last year, and the exports of all kinds amounted to £1,900,337. Taking the imports of caoutchouc first, we find that the general fall in the prices of commodities does not alone account for the fact that the total value only reached £1,975,658 in 1885, compared with £2,266,870 in 1884, and £3,618,276 in 1885; for the decrease in the quantities in the same periods is about proportional, the figures being 179,703 cwt. in 1885, 198,001 in 1884, and 227,422 cwt. in 1883. By the same mode of comparison, the returns show smaller imports of gutta-percha, these being 53,894 cwt., valued at £348,104 in 1885; 62,713 cwt., valued at £462,746 in 1884, and 63,073 cwt., valued at £468,388 in 1885.

The exports of "manufactures of caoutchouc" (British and Irish produce) are steadily declining—a melancholy fact, which surprises no one in these days of depressed trade and severe competition. Last year's exportation (the declared value only being given in the returns before us) is put down at £910,726, as against £1,004,730 in 1884, and £1,070,365 in 1883. The exports, or, more properly speaking, *re-exports*, of raw and manufactured rubber (foreign and colonial merchandise) have also declined during the past year both in quantity and value. In 1883 the exports (or *re-exports*) of caoutchouc were 102,570 cwt., of the value of £1,463,331; in 1884 the quantity was greater—109,856 cwt—and the value considerably less, viz., £1,155,489: while last year both quantities and values decreased, the former totalling 92,272 cwt., the latter £918,955. The exports (or *re-exports*) of gutta-percha, on the other hand, increased in volume in 1885, the figures being 9,666 cwt., valued at £70,656, as against 7,687 cwt., of the value of £56,693 in 1884. The latter year, however, compared unfavourably with 1883, when the totals were 9,862, cwt., valued at £84,019—rather more than those of 1885. When the finally revised and more complete returns are issued we shall be curious to see how far foreign competition, and especially that of Germany, has brought about the reduction of the volume of business which has marked the year 1885.

The "depression" at home is assuredly not the sole cause of the present unsatisfactory position of the rubber trade, as indicated by the Board of Trade statistics.—*Indiarubber and Guttapercha Journal.*

SPECIMENS OF RUBBER SALES IN LONDON 1889.

The following sales by auction have taken place during August:—

On Friday, August 6th Messrs. Donald Gray & Son offered for public auction:—

187 bags Mozambique
5 barrels African

but at the sale they were bought in.

On Friday, August 13th, Messrs. Canny & Colborn offered:—

200 bags Mozambique.

Messrs. Lewis & Peat offered:—

10 barrels Mangabeira
4 bales Colombian
25 packages Madagascar
292 bags Mozambique
20 cases Mozambique.

Messrs. Hale & Son offered:—

210 packages Mozambique
4 packages Madagascar
11 packages African.

Messrs. Donald Gray & Son offered:—

100 bags.

The *Public Ledger*, of August 14th, reports, of the sale as follows:—

'Indiarubber remains firm, and at auction 10 barrels pinky Mangabeira bought, in at 2/1; 4 bales good mixed Colombian sold at 2/-; of 176 cases, 811 bags and 20 cases Mozambique, 200 packages sold; common ball, 1/7¾; fair ditto 2/3 to 2/4; good small (marbles), 2/5½; large, 2/5½; unripe 0/9¼ to 1/-; spools 2/4; liver, 1/8¾ to 1/10¼; 39 packages Madagascar, partly sold, pinky sort, 2/5½ to 2/6; dark, 2/0½; of 24 packages African, 10 packages West Coast sold good ball, 2/0¼ to 2/2½; dark and spongy, 1/-to 1/2½."

Messrs. Lewis & Peat report:—

The market is higher and active. 75 tons fine Para sold at 3/4, good negro head at 2/7 per lb.; 400 bags unripe root Mozambique at 10d., and Assam at high rates at sale today.

MANGABEIRA.—10 packages sold, good clean but soft, 1/11 per lb.

COLOMBIAN.—4 packages sold soft white spongy, 2/- per lb.

MADAGASCAR.—39 packages offered and 17 sold; pinky, rather mixed with dark, very damp, 2/5½ to 2/6; dark mixed, 2/0½.

MOZAMBIQUE.—987 bags offered, 261 sold.

Good clean hard ball, 2/5½; two lots, 2/5¾ to 2/6 per lb; fair softish ball, 2/3 to 2/4; middling sausage, 2/4; unripe root, 10d.; good ditto, 11d. to 1/-; very foul, 9¼d. to 9½d.; ball pickings, sandy and foul, 1/7¾; liver middling, 1/10¼ per lb.

ACCRA.—16 packages offered and 9 sold; ordinary lump, 1/2 to 1/2½ softish, 1/-per lb.

SIERRA LEONE.—10 packages offered and 2 sold; good niggers, 2/2½; good flats, 2/0¼ per lb.

3rd September.

The market for Para is quiet. Of Mozambique about 400 bags sold privately; good hard clean ball, from 2/5½ to 2/6 per lb.; middling white softish from 2/3 to 2/4 per lb.; unripe root from 10d. per lb.

STOCK.	1st Sept. 1886.		1st Sept. 1885.
Mozambique... ...	244 tons	against...	184 tons.
All sorts	1,174 "	... " ...	1,900 "

Messrs. Hale & Son report:—

MOZAMBIQUE.—Of 1,019 packages offered, 251 packages sold at full rates. Good ball, slightly false, backed and sandy 2/5½; fair small, spools, part

dark, 2/4; soft, white, pressed ball, rather mixed to fair, slight sandy, 2/3 and 2/4; mixed sandy ball, 1/7¾; ordinary and heated ditto, 1/1; good red barky ball, 6 bags, 11d. and 1/-; unripe, very barky ball, old import, 9½d., just landed 9¼d.

MADAGASCAR.—39 packages offered, 17 packages sold, good pinky lump, rather mixed, and part slightly heated 2/5½ to 2/6; mixed black ball, a litte pinky, slightly heated and sticky, 2/0½.

WEST COAST, AFRICAN.—29 packages offered, 9 packages sold; Accra porous lump, 1/2 to 1/2½; sticky flake, 1/-; Sierra Leone niggers, 1 barrel, fair slight barky and sandy, 2/2½; smooth-coated ditto, damp, 1 barrel 2/0¼.

COLOMBIAN.—4 barrels middling, pressed sheet, sold at 2/-.

On August 20th, Messrs. G. T. Benton & Son offered:—

47 bales West Indian
19 bales Colombian.

Messrs. Donald Gray & Son offered:—

351 packages Mozambique.

At auction: 47 bales Central American sold; good scrap, 2/7 to 2/7½ 19 bales Colombian, bought in; 133 cases, and 218 bales Mozambique, chiefly withdrawn.

On August 27th, Messrs. Lewis & Peat offered:—

18 cases Mangabeira
16 bales West Indian
4 bales Colombian
65 cases Madagascar
275 bags Mozambique
2 cases manufactured
2 bales Balata.

Messrs. Hale & Son offered:—

552 packages Mozambique
10 bags Assam
1 case Madagascar
6 packages African
1 case.

Messrs. Brooks & Green offered:—

7 packages.

Messrs. Donald Gray & Son offered:—

425 bags Mozambique
33 cases Mozambique
5 barrels African.

The *Public Ledger*, of August 28th, states as follows:—

BALATA.—2 bales sold at 1/2 to 1/3¼.

This week about 40 tons Para have been sold, fine at 3/5, but at the close 3/6 was asked. At auction today 18 cases pinky Mangabeira sold at 1/11, of 16 bales Central American 2 bales good sheet sold at 2/7¼, 4 bales Colombian bought in. The large quantity of 1,287 bags Mozambique, consisting largely of unripe, met little demand, and 100 bags sold, middling to fair ball, 2/3 to 2/7. Spools mixed 2/5 of 71 packages. Madagascar 3 packages sold, small 2/5, out of condition 2/3, 11 packages African, and 10 bags bought in.—*Indiarubber and Guttapercha Journal.*

INDIAN RUBBER is growing scarcer yearly, and as wherever it, has been found the practice has been to cut it down and destroy it, its production seems likely to decrease, and its price to increase considerably. Our Indian rubber is obtained from a creeper, a species of *Willoughbeia* which grows wild under forest shade, so that if young plants are put out at the foot of each forest tree, no further expense need be incurred in connection with its cultivation beyond a slight watch being kept to see that bands of native collectors do not visit the locality, and in four years a large quantity would be ready for collection. There need be scarcely any limit to the size of the space planted up

with it, and the work of taking care of a large acreage planted with Indian rubber would seem to be particularly fitted for anyone with natural history or sporting proclivities. There would be some difficulty at first in getting seeds or slips to plant in nurseries, but once they were obtained, all the rest would be easy.—*Straits Times.*

INDIA RUBBER has been quiet; there have been large supplies of Mozambique, and in sale the unusually large supplies of 1,783 bags 171 cases Mozambique of fresh arrival was all bought in, except 20 bags which sold at 2s 1¾d to 2s 2¼d for liver and 1s 4½d for white ball; 500 bags sold, some unripe 10d. Of 77 packages Madagascar 18 packages sold, black coated sticky 2s 2d, rather spongy to fair white 2s 6¼d to 2s 6½d. 14 packages Assam bought in. 11 baskets fine bright Java sold at 2s 7¼d.

Statistics for the month of January to September in London:—

	Imports.			Delivered.			Stock 30th Sept.		
	1886	1885	1884	1886	1885	1884	1886	1885	1884
East Indian...Tons	464	504	564	510	598	629	130	257	417
Madagascar	65	58	99	73	63	92	22	48	78
South American..	136	157	258	192	195	289	40	137	254
Mozambique	647	495	852	582	581	817	284	232	434
African (other kinds)	13	13	7	13	15	8	1	—	5

—*Barber Brother's Circular, October 6th, 1886.*

RUBBER IN BRAZIL.—The following extract from a sketch of the Physical Geography of Brazil, lately published, gives a new idea of the importance of *rubber*:—"Amongst the immense stores of valuable vegetable productions of this great forest, the india-rubber tree figures pre-eminently. It exists in such vast quantities, and the collection of the juice is so very lucrative, that it has attracted to even the most remote rivers thousands of adventurous Brazilians. Rubber is doing for the Amazons what gold did for Australia and California; although most other industries on the Amazons are neglected and paralyzed, rubber has enabled Para, Manaos, and other riverine cities to make unprecedented progress. It has covered thousands of miles of rivers with steamers, and spread a vast population over vast areas that would otherwise have remained dormant for many, many years."

RUBBER IN BRAZIL.—The Parà statistics not having come to hand, only those for Amazonas are published, viz.:—

		weight.		value.
1882-83	...	718,137	kilos.	2,253,369$
1883-84	...	1,040,358	,,	2,564,431
1884-85	...	1,412,407	,,	2,505,580

The minister suggests that the municipalities and provincial legislatures should take steps to replant the tree, in the proper situations, near villages, not only to prevent the destruction of this source of wealth, but also by reducing the cost of harvesting to place the article on a better footing as regards foreign rubber.—*Rio News.*

GUTTA-PERCHA.—Sir John Kirk, writing in December last, forwarded a sample of native African gutta-percha, the produce of a yet unknown tree which he found at Mombasa. From the papers now published, it would appear that after examination of the specimen there remained no doubt that the substance would prove an acceptable addition to the present supplies, its value being about 10*d* per lb. At the same time Sir John Kirk also forwarded specimens of some Indiarubber taken from plants supplied from Kew Gardens about five years ago, these having flourished and propagated freely at Zanzibar. The report on this specimen valued it, if taken from the trunk of the tree, at about 1*s.* 9*d.* to 2*s.* per lb as Sir Joseph Hooker, late Director of the Royal Gardens at Kew, remarks, "the attention of Her Majesty's Consular officers in these countries (India-rubber producing states) cannot be too closely addressed to matters of this kind, which are not merely of great scientific interest, but may from the basis of a lucrative and beneficial trade."—*Indian Agriculturist.*

FUTURE SUPPLY OF INDIARUBBER.

To the Editor of the Indiarubber and Guttapercha Journal,

SIR,—In the various topics discussed in your paper I have not hitherto seen anything bearing upon a very vital question—The future supply of Indiarubber.

This is a most important matter for manufacturers. The variations in the price of virgin rubber during the last eight years have been tremendous. This has been accompanied by, with very few exceptional periods, an almost continuous decline in the price of manufactured goods, so that the latter have come to be sold at prices based almost entirely upon the lowest price of rubber. When that "lowest price" has been exceeded, it has meant unremunerative business, if it has been much exceeded, it has meant positive and heavy loss to the manufacturer.

To avoid the latter evil, the manufacturer has in many, perhaps most, instances resorted to the use of various substitutes, about which all agree that their incorporation with rubber will ultimately give Indiarubber goods a bad reputation for both utility and durability. There will be great danger that the consumer—the general public—will attempt in disgust to discard the use of articles bearing any appearance of rubber.

The great fluctuations of which I have spoken have arisen always from a deficient supply. A deficiency not always great but often so that it could be easily intensified by the watchfulness and the doings of speculators. The cure consists in so increasing the supply that there will always be sufficient for all demands. This will ensure a low and also an even price. The even price will give the manufacturer a reliable basis for his calculations; the low price will tend to decrease the use of substitutes, and induce a permanent liking for indiarubber goods in proportion to the satisfaction they give.—I am, &c., MANUFACTURER.

CASTILLOA ELASTICA.—M. A. Lawson, Esq., Director of the Government Parks and Gardens, Nilgiris, in his Report for 1885-6, says of *Castilloa Elastica* :—"Colonel Campbell-Walker in a letter to the Board of Revenue, No. 2156, of the 27th January, 1886, embodied in G. O., No. 231, of the 24th March, 1886, Revenue, states that this valuable *Indiarubber* producing tree has at last been finally established by Mr. T. J. Ferguson at Calicut. I saw Mr. Ferguson's trees 18 months ago, and they were growing magnificently, and as it has at last been found easy to raise these trees from cuttings, I hope they will in the future form no unimportant item in the forestry of this place. The other rubber-producing plants have so far been a failure, either through their not yielding as much rubber as they do in America, or because we have not yet learnt how to tap the trees properly."—*Indiarubber and Guttapercha Journal.*

RUBBER MILK.—The method of treatment for congealing the rubber milk in the Para district, which equally applies to the milk of the *Hevea Braziliensis* and *Mangabeira*, is as follows:—Small cups are attached to the trees, and, when filled with juice, are emptied into tin pails of a certain size, having close fitting lids, the cups being again attached to the trees. After going the round of the trees, the contents of this pail are emptied into another a size larger, and so on, till the covered pail of largest size is filled and ready to be strapped on to the saddle of a mule for removal. By this plan the natives are saved the trouble of condensing and preparing the milk for market, by smoking. The large can of rubber milk on arriving at the *magasin*, is emptied into a bath of water, the temperature best suited to the rubber being a matter of experience. The lumps of rubber that form in the bath are immediately pressed into thin, flat sheets, and carefully wiped. By this means the acid is forced out of the cells or pores in the lump, thus preventing the so-called "rotten" appearance. The author is of opinion that the African rubbers yielded by the *Landolphias*, prepared in this manner, will produce a strong rubber. The African rubbers now sent here do not yield, when strained and cleaned, more than 30 to 55 per cent of pure rubber gum, owing to the natives adulterating with sawdust, bark dust, &c., to overcome the inconveniences of the stickiness of the juice. The amount of resin in milk varies largely.—*Indiarubber and Guttapercha Journal.*

CAOUTCHOUC (RAW).

IMPORTS INTO THE UNITED KINGDOM.

From		1883.	1884.	1885.
Aden	cwt.	9,339	2,845	3,596
	£	125,495	27,972	30,917
		268s.	196	172
Africa, East (Portug.)... ...	cwt.	3,048	980	797
	£	36,700	9,970	7,600
		240s.	203	190
,, ,, (Native)	cwt.	7,664	4,129	4,337
	£	109,663	42,046	30,756
		286s.	203	141
,, South (Brit.)	cwt.	431	933	1,027
	£	5,027	9,386	9,060
		233s.	201	176
,, West (Brit.)... ...	cwt.	11,767	14,250	11,615
	£	135,619	140,422	97,855
		230s.	197	168
,, ,, (Portug.) ...	cwt.	3,382	2,998	2,559
	£	48,751	29,177	24,465
		288s.	194	191
,, ,, (Other Parts) ...	cwt.	21,151	16,762	15,830
	£	249,919	139,953	143,297
		236s.	167	181
America, Central	cwt.	3,125	2,125	2,121
	£	47,122	24,921	20,401
		301s.	234	192
,, U. S. of	cwt.	12,817	15,707	3,895
	£	198,856	56,362	26,425
		310s.	71	135
Brazil...	cwt.	93,158	91,061	97,234
	£	1,953,142	1,372,823	1,255,978
		419s.	301	258
Columbia, U. S. of	cwt.	2,255	2,141	430
	£	30,627	23,039	3,946
		271s.	215	183
Ecuador	cwt.	400	542	39
	£	6,080	5,551	390
		304s.	204	200
France	cwt.	3,225	4,414	3,813
	£	30,393	28,015	28,302
		188s.	127	148
Germany	cwt.	2,451	1,921	1,527
	£	28,639	18,074	11,916
		233s.	188	156
Holland	cwt.	1,764	1,875	2,138
	£	17,754	13,364	21,269
		201s.	142	199
India, Brit. (Bombay and Scinde)	cwt.	13,601	11,171	6,122
	£	168,682	102,870	54,974
		248s.	184	179
,, ,, (Bengal and Burmah)	cwt.	8,448	6,246	6,151
	£	96,252	57,322	57,900
		227s.	183	188
Madagascar	cwt.	3,982	1,100	41
	£	65,286	12,295	361
		328s.	223	176

IMPORTS OF CAOUTCHOUC (RAW) INTO THE UNITED KINGDOM.—*(Continued.)*

		1883.	1884.	1885.
From				
Mauritius	cwt.	1,351	1,339	1,098
	£	17,126	14,192	11,493
		254*s.*	212	209
Portugal	cwt.	5,537	4,461	7,238
	£	77,341	47,036	75,010
		279*s*	210	207
Straits Settlements	cwt.	17,231	11,010	7,662
	£	171,384	89,980	61,080
		198*s.*	163	160
Uruguay				295
				3,852
				261
Other Countries	cwt.	2,974	834	577
	£	32,959	7,729	4,488
		221*s.*	185	155
Totals ...	cwt.	229,101	198,844	180,141
	£	3,65,817	2,272,499	1,981,735
		2318*s.*	228	220

GUTTAPERCHA (RAW).

IMPORTS INTO THE UNITED KINGDOM.

	1883	1884	1885	1886
From				
British East Indies:				
Bengal			cwt 3	
			£ 25	
			166s.	
Bombay & Scinde ...		cwt. 345	21	
		£ 3,014	137	
		174s.	130	
British Guiana	cwt. 1,017	1,536	1,149	
	£ 10,999	16,580	9,100	
	216s.	216	158	
China	cwt. 851	706	—	
	£ 7,254	8,352	—	
	170s.	236	—	
France	cwt. 748	593	—	
	£ 7,074	5,630	—	
	189s.	189	—	
Holland...	cwt. 2,149	1,631	1,631	
	£ 23,362	11,146	12,706	
	217s.	136	155	
Straits Settlements	cwt. 58,706	57,669	50,810	
	£ 425,813	416,394	323,518	
	145s.	144	127	
Other Countries	cwt. 329	233	225	
	£ 2.379	1,630	1,647	
	144s.	140	146	
Total cwts.	cwt. 63,8 00	62,713	53,839	40,697
„ £	£ 476,881	462,746	347,133	269,808
Average price per cwts.	149s.	147s.	129s.	132s
Stock in London ...	cwt. 41,20	38,460	50,640	50,800
Reported by Smith & Son.				
Imports to London	£ 52,160	54,300	48,180	31,520

Imports of CAOUTCHOUC (Raw) in cwts. and £'s into the United Kingdom.

	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Twelve mos.' cwt.*a* ...	169,587	172,077	181,726	229,101	198,844	180,141	192,518
,, ,, £'s *a* ...	2,387,947	2,254,618	2,754,692	3,652,817	2,272,499	1,981,735	2,202,746
Av. price per cwt. ...	281s	262s	303s	318s	228s	220s	228s

Imports of GUTTAPERCHA (Raw) in cwts. and £'s into the United Kingdom.

Twelve mos.' cwt.*a* ...	65,856	68,445	72,936	63,800	62,713	53,839	40,697
,, ,, £'s *a* ...	527,872	502,906	539,814	476,881	462,746	347,133	269,808
Av. price per cwt. ...	160s	146s	148s	150s	147s	129s	132s

Exports of CAOUTCHOUC (Raw) in cwts. and £'s from the United Kingdom.

Twelve mos.' cwt.*a* ...	76,732	94,913	101,655	102,570	109,858	89,810	109,416
,, ,, £'s *a* ...	1,063,775	1,174,829	1,537,567	1,463,350	1,155,487	963,515	1,281,499
Av. price per cwt. ...	277s	247s	302s	285s	210s	214s	234s

Exports of GUTTAPERCHA in cwt. and £'s from the United Kingdom.

Twelve mos.' cwt.*a* ...	8,529	8,226	12,323	9,862	7,687	9,666	11,525
,, ,, £'s *a* ...	88,194	65,309	113,713	84,019	56,693	70,656	75,459
Av. price per cwt. ...	206s	158s	184s	170s	147s	146s	130s

Exports of MANUFACTURES OF CAOUTCHOUC in £'s from the United Kingdom.
(British only.)

Twelve months *a* ...	853,067	954,574	1,017,289	1,091,873	1,019,244	910,763	971,052

Home Consumption: CAOUTCHOUC (Raw) cwts.

Twelve months *a* ...	92,855	77,164	80,071	126,531	88,988	87,431	—

Home Consumption: GUTTAPARCHA (Raw) in cwts.

Twelve months *a* ...	57,327	60,219	60,613	53,938	55,026	44,228	29,172

a Revised figures.

—*Indiarubber and Guttapercha Journal.*

PRICES OF RUBBER AND GUTTAPERCHA.

(*From Lewis & Peat's London Price Current, March 17th, 1887.*)

Indiarubber—Mozambique Ball and Sausage } red, hard ...	... 2s 5d a 2s 6½d
,, } white softish	... 2s a 2s 3d
,, unripe root ...	... 10d a 1s 2½d
,, ,, liver ...	... 1s 8d a 2s
,, Assam—Good to fine ...	... 2s a 2s 7d
,, Common foul and mixed	... 8d a 1s 10d
,, Rangoon—Fair to good clean	... 1s 6d a 2s 6d
,, Madagascar—Good to fine pinky & white	... 2s 4d a 2s 6d
,, Fair to good black	... 1s 11d a 2s 2d
Guttapercha—Genuine fine clean Banj & Macassar	... 2s 4d a 3s 3d
,, Sumatra—Barky to fair	... 6d a 2s 3d
,, Reboiled common to fine clean	... 1d a 1s 4d
,, White Borneo—Good to fine clean ...	... 11d a 1s 3d
Inferior and barky ...	... 1d a 8d

APPENDIX.

INDIARUBBER AND GUTTAPERCHA.

(From Dr. Trimen's Report for 1886 on the Royal Botanic Gardens in Ceylon, published May 1887.)

INDIARUBBER TREES.—The Para rubbers (*Hevea brasiliensis*) are now over ten years old, and the largest tree has a girth of 49 in. at a yard from the ground. Some plants have been sent to Queensland.

The *Castilloa elastica* trees are the same age. They are not now growing so rapidly as at first; the largest is 38 in. in circumference at a yard from the ground. A Wardian case with 250 seed of this was sent in May to the Conservator of Forests, Tavoy, and fifty young trees have been planted at Kandy. The paper by Sir J. D. Hooker, referred to in my last report, has been published.* It is illustrated by a fine coloured plate of the tree cultivated here, drawn by W. De Alwis, the draughtsman of the gardens. Sir Joseph points out that our plant, which it will be remembered is the "Caucho" tree collected by Cross in Darien in 1875, differs slightly from the original *Castilloa elastica*, Cav. (the "Ulé" tree of Mexico and Central America), in having the leaves less hairy beneath, and the seeds of a somewhat different shape. He does not, however, apparently consider these differences sufficient to warrant another specific name, and our plant may continue to be called *C. elastica*.

Of the East African rubbers, the oldest plant of *Landolphia Kirkii*, the climbing stem of which is now about 10 in. in circumference, produced fruit this year for the first time. The seeds are few in number, and contained in a thin-coated globular berry, and each is covered with a sweet orange-coloured pulp.

GUTTA-PERCHA TREES.—The "Gutta Taban Patih" (*Dichopsis pustulata*) have attained 12 ft. in height at Peradeniya, and the "Gutta Sundek" (*Payena Leerii*), which does better at Henaratgoda, are now about 61 feet-high at that Garden.

ON THE CASTILLOA ELASTICA OF CERVANTES, AND SOME ALLIED RUBBER-YIELDING PLANTS.

BY SIR J. D. HOOKER, K.C.S.I., C.B., F.R.S., F.L.S.

(From the Transactions of the Linnean Society of London.)

Read December 3rd, 1885.

The great importance of the Indiarubber trade renders it necessary that the plants yielding this valuable product should be known with scientific accuracy. Of these, the Ule, that which yields the rubber of Mexico and Central America (*Castilloa elastica*), is the earliest described, and might hence be supposed to be well-known. It is the purport of this communication to show that this is not so, and that probably more than one rubber-bearing species of that genus exists in Central America under this name.

Attention was first called to this subject by the receipt at Kew, from Dr. Trimen, Director of the Ceylon Botanical Gardens, of a specimen and a drawing—with complete analysis of the flowers and fruit—of the plant sent out from Kew in 1876 as *Castilloa elastica*, and which drawing differed considerably from Cervantes's figure and description of the Ule of Mexico. The tree from which the specimens were taken and drawing

* Trans. Linnean Soc., ser. 2, II., page 209.

made, was raised from one of the cuttings procured in Darien (Panama) by Mr. Cross in 1875, and which, after being grown on at Kew, were distributed to various tropical Colonies, as detailed in Mr. Thiselton Dyer's account of Mr. Cross's mission and of the introduction into Europe of the Indiarubber plant which is appended to this communication. It will be seen from that account that Mr. Cross sent the plant under the name Caucho, and that the locality where he procured it, the forests of the rivers Chagres and Gatun (well-known localities for Indiarubber collectors) is considerably to the south of the botanically ascertained stations for the Ule. In selecting these forests for the purpose of collecting seeds Mr. Cross was, no doubt, indebted to information obtained by the late Mr. Sutton Hayes of Panama, and which is attached to specimens of an Ule, which latter, however, he procured from the Republic of San Salvador; and for assuming that the Caucho is the Ule or *Castilloa elastica* of Cervantes, he probably relied on the testimony of Cavanilles, who, in a notice of the Caucho of Darien (Panama) in the Ann. de Hist. Nat. Madrid, ii. p. 126, regards it as the same with the Ule of Cervantes, whose description he quotes at full length. Unfortunately Mr. Cross sent no other herbarium specimens of the Caucho than some very badly preserved old leaves and seeds, so that, until the arrival of Dr. Trimen's materials, the means of identification were wanting.

I have next to advert to specimens of the fruits of three forms or species of *Castilloa* from the forests of Honduras, preserved in fluid kindly procured by W. H. Langton, Esq., Secretary of the Belize Estate and Produce Company; two of these are named Ule, and both stated to yield the Honduras rubber; the third is named Tunu, and said to yield a gutta-percha. These all differ more or less from the Caucho of Darien, collected by Mr. Cross, and one of them may, I think, be safely referred to the *C. elastica* of Cervantes. Unfortunately only one of them is accompanied with specimens of foliage, which, however, is that of the fruit which I attribute to *C. elastica*, and it further agrees with that of Mexican specimens of Ule. The other materials at Kew referable to *Castilloa* consist of:—flowers and leaves of the Ule from Mexico collected by Ervendberg, Schiede and Deppe, and by Bourgeau; leaves of the Honduras Ule from D. Morris, Esq.; of the Nicaraguan Ule collected by P. Levy, and named var. *Costa-ricensis* Bureau; San Salvador specimens of foliage and dried fruit from Mr. Sutton Hayes; flowering branches from Guatemala, collected by Fredericsthal; and leaves and flowers of the Jeve from the plains near Guyaquil, sent by Spruce as *C. elastica.*

These herbarium specimens present no characters of habit, foliage, or flowers to distinguish them from *C. elastica*: all the branchlets are clothed densely with substrigose buff-coloured hairs; the leaves are scabrid above, and densely hirsute or hirsutely tomentose beneath. On the other hand Cross's indigenous specimens of Caucho, and those cultivated in Ceylon, have the branchlets less clothed with hairs, and the under surface of the leaves less thickly tomentose.

Turning to the fruits in fluid, to the figure from Dr. Trimen, and to that accompanying Cervantes' account of Ule, these all agree in consisting of a fleshy circular disk, 1-3 inches in diameter, clothed beneath and on the circumference with densely imbricating triangular scales, and bearing on the upper surface 8-30 confluent orange-red, thick, coriaceous, one-seeded carpels, with more or less prominent pyramidal crowns. These carpels present important differences, possibly specific; but from the materials available it is not possible to determine what may constitute a species amongst them, and I shall therefore confine myself to defining the typical *C. elastica* more exactly than has hitherto been done, and follow this by descriptions of the forms allied to it.

I. Castilloa elastica*, *Cervantes in Gaz. Litt. Mexic.* 1794 (*translated in Tracts relative to Botany, London,* 1805, p. 235, t. 9): ramulis crassis strigoso-hirsutis, foliis amplis breviter petiolatis bifariis oblongis v. obovato-oblongis abrupte acutatis basi cordatis integerrimis v. apicem versus denticulatis supra scabridis subtus dense hirsutis tomentosisve, nervis utrinque 17-21, stipulis 2-3-pollicaribus deciduis, receptaculis axillaribus turbinatis bracteis triangularibus persistentibus imbricatis tectis, ♂ breviter pedunculatis, ♀ subsessilibus, floribus ♂ achlamydeis densissime confertis, staminibus (floribus singulis?) bracteolis immixtis, fl. ♀ perianthiis ovoideis infra medium connatis ore minute

* Published anonymously, but known to be by Chas. Kœnig, F. R. S., Keeper of the Mineralogical, Department of the British Museum.

3-4-lobo, receptaculo fructifero disciformi crasso, basi margineque bracteis imbricatis appressis decsissime tecto, carpellis maturis carnosis infra medium connatis superne liberis pyramidatis minute pubescentibus, parte libera 3-4-sulcata angulis rotundatis apice depressa 3-4-loba.—*Cavanilles in Ann. des Hist. Nat. Madrid* (1,800), ii. p. 126; *Trécul in Ann. Sc. Nat.* ser. 3, viii. 136, t. 5, fig. 142-148; *Ramon de la Sagra, Flora cubensis*, iii. p. 223; *Collins, Report on Caoutchouc of Commerce* (1872), p. 11, t. 2; *Hemsley, Biol. Centr.-Amer. (Botany)*, iii. p. 149; *Morris, Colony of British Honduras* (1883), p. 75, *cum ic. xyl.*—C. costa-ricensis, *Liebman, K. Dansk. Vidensk. Selsk. Skrift.* ser. 5, p. 319; *Mexicos og Central Americas Neldeaglige Planter* (1851), pp. 34, 35. *Hemsley. l. c.* (Plate XXVIII. figs. 1—3).

Hab. MEXICO, from lat. 21° southwards; GUATEMALA; HONDURAS; San SALVADOR; COSTA-RICA and NICARAGUA, in low forests.

A lofty deciduous tree with milky juice; trunk 8-12 ft. in circumference; bark smooth, soft; branchlets very stout, with large pith and brown bark, extremities, densely clothed with long fulvous hairs. *Leaves* 12-18 by 4-7 in., alternate and bifarious, firmly membranous, broadly, oblong or obovate-oblong, abruptly acuminate, base cordate, entire or obscurely toothed at the tip, margin with minute tufts of hairs, scabrid above, beneath densely clothed with tawny hairs, midrib prominent beneath; nerves 17-21 pairs; petiole ⅓-1 in., stout; stipules 2-3 in., clothed with tawny hairs, deciduous. *Flowers* monœcious, contained in solitary, axillary, turbinate, fleshy receptacles ¾-1 in. in diam, clothed outwardly with minute, densely imbricate, triangular, appressed, puberulous bracts. *Staminate receptacles* ¾-1½ in. in diam., shortly stalked, usually subcompressed, cup-shaped at the top, and covered densely with stamens mixed with bracteoles which do not overtop the margins of the cup. *Pistillate receptacles* similar, but rather smaller, and subsessile; flowers confluent; perianth fleshy, greenish, limb minutely 3-4 toothed; ovary immersed in the disk; styles 2, rarely 3. *Fruiting receptacle* (in Honduras specimens) 1¾-2 in. in diam.; ripe carpels coriaceously fleshy, with pyramidal free pubescent crowns ⅓ in. high; crown 3-4 grooved laterally, with rounded angles and obtuse depressed 4-lobed tips. *Seeds* ¼-⅓ in. in diam.; more or less immersed in the free crown of the carpel; testa white, papery when dry; cotyledons thick, plano-convex, radicle minute, superior.

The character by which I identify this with the plant of Cervantes is that of the free part of the ripe carpels, which that author describes as "apice excavato;" in all the other forms noticed below these crowns are acutely 3-4-angled with acute tips. The reduced figure of the fruit given by Cervantes shows the character of the grooved sides and rounded angles of the carpels, but not their indented tips.

Trécul gives Cuba as a native country for *C. elastica*, on Ramon de la Sagra's authority, but a reference to the latter author's 'Flora Cubensis' shows that it is known in that island only in the Botanical Gardens of Havana.

II. The Caucho, or Darien plant. Leaves less thickly tomentose beneath. Fruiting receptacles 2-3 in. in diam.; crowns of the ripe carpels prominent, pyramidal, acute, acutely 3-4-angled. Seed ⅓ in. in diam., more or less immersed in the free crown of the carpel.—Darian on the Chagres and Gatun Rivers.—*C. Markhamiana*, Markham (not of Collins), PeruvianBark (1880), p. 453.* (Plate XXVII. figs. 1-17.)

III. Fruit referred to Ule from the Belize Estate and Produce Company.—Fruiting receptacle 1-1¼ in. in diameter; crowns of the ripe carpels prominent, acute, acutely 3-4-angled. Seeds ¼ in. in diam., more or less immersed in the free crown of the carpel.—Honduras and Nicaragua. This appears to be a small seeded variety of the Darien species. (Plate XXVIII. figs. 4-6.)

IV. Fruit of the Tunu, or gutta-percha yielding plant, from the Belize estate and Produce Company.—Fruiting receptacles 2-2½ in. in diam.; crowns of ripe carpels very low, subacute, acutely 3-4-angled. Seeds ⅓ in. in diam., immersed in the receptacle far below the crowns of the carpels.—Spanish Honduras. (Plate XXVIII. figs. 7-9.)

Before dismissing the subject, it may be well to allude to the remarks made by Mr. Cross on the formation of disarticulating branches on the young plants of

* *C. Markhamiana*, Collins, 'Report on the Caoutchouc of Commerce,' p. 12, t. 3, is no doubt correctly referred by Bentham, Gen. Pl. iii. p. 372, to *Perebea*.

the Caucho, and which, no doubt, occur in other species of *Castilloa*. They are thus described by Mr. Cross in a letter dated April 26, 1877:—"In the forests the young *Castilloa* plants push up rank stems rapidly to a great height, which, during the progress of growth, throw out at variable distances a number of leafy shoots. These, on becoming mature, begin to wither, and finally seperate from the surface of the trunk by an articulated or jointed process. I did not consider them true branches, just because the wood was not properly formed, the buds were imperfectly developed, and I found they were not easily propagated. It may be different with shoots developed by compressed pot culture. But when the tree begins to flower, true branches are formed which do not drop off. At times the trunk, after running up to a certain height, divides into two or three stems, each furnished with numerous short, stiff, upright branches which are permenant, and ripen fruit abundantly. Probably, however, the description of shoots alluded to are produced at times during the entire period of the growth of the tree. A similar phase of growth appears to take place with other species of forest trees in the hotter parts of America."

The above information is given in abstract by Mr. Lynch, Curator of the Cambridge Botanic Garden, with due reference to its author, in his interesting paper "On the Disarticulation of Branches," published in the 16th volume of our Journal (p. 182), accompanied by an excellent drawing of the phenomenon, and the observation that the deciduous branches strike under cultivation as freely as the permanent ones. The figure of Cervantes shows a contraction at the base of the branches, where disarticulation would occur.—J. D. HOOKER.

In the summer of 1875 the India office despatched Mr. R. Cross (who, in 1860, had accompanied Dr. Spruce in his expedition to Ecuador to collect plants of *Cinchona succirubra*) to Darien to obtain seeds and plants of *Castilloa elastica**. This mission he successfully accomplished. He reported as follows (August 4, 1875) to C. R. Markham, E-q., C. B.:—

"By this mail I have despatched (addressed to the Under Secretary of State for India) a small bag containing upwards of 7,000 seeds of the Caucho tree which I have just collected in the centre of Darien. There is only *one* species, the difference being in those growing in the shade or exposed. The seeds were collected in good condition and perfectly ripe, but from observations on a few gathered on first arrival they do not appear to keep well, containing, even when mature, a milky juice.

* * * * * * * *

The interior of the Darien forests would frighten most people. The undergrowth is composed of boundless thickets of a prickly-leaved species of *Bromelia* often 8 to 10 ft. high, the ground swarms with millions of ants, and the snakes raise themselves to strike at any one who approaches.

"The Caucho tree grows not in inundated lands or marshes, but in moist undulating or flat situations, often by the banks of streamlets, and on hill sides and summits where is any loose stone and a little soil. It is adapted for the hottest parts of India, where the temperature does not fall much below 74° Fahr. The tree is of rapid growth, and attains to a great size, and I am convinced that when cultivated in India it will answer the most sanguine expectations that may have been formed concerning it. I have been up the Chagres and Gatun rivers. I came out on the railway about 7 miles from Colon. I go back to the same place (the village of Gatun), from which place by the river the Indiarubber forests are reached."

As stated in the Kew Report for 1875 (p. 8), Mr. Cross's expectations as regards the seeds were realized. The whole parcel failed to germinate. Mr. Cross, however, with considerable difficulty, and after undergoing shipwreck,† succeeded in bringing safely to Kew (Oct. 3) a considerable collection of cuttings from which a supply of plants was raised. Of these, two plants were despatched to Dr. Thwaites, Director of the Royal Botanic Gardens, Peradeniya, Ceylon, April 27, 1876, and thirty-one on August 9 following. Of these last, twenty-eight arrived alive (Kew Report, 1876, p. 9).

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* See also Mr. Markham's account of the enterprise in 'Peruvian Bark' (London, 1880) pp. 452-454

† Markham, *l. c.* p. 453.

A further consignment of twenty-four plants was sent, Sept. 15, 1877, to Dr. Thwaites, who meanwhile had been establishing the former consignment in the tropical garden at Heneratgoda (Kew Report, 1877, p. 16). Here they made satisfactory progress, Mr. Morris describing them, May 18, 1878, as growing "into broad spreading trees with a very majestic air." Dr. Thwaites, however, met with great difficulty—contrary to the Kew experience—in propagating the tree by cuttings (Kew Report, 1878, p. 14).

In 1880 Dr. Trimen, who had succeeded Dr. Thawaites as Director of the Royal Botanic Gardens, Peradeniya, reported:—"Much better success now attends the propagation by cuttings of this fine species. Our largest trees at Heneratgoda have now a circumference of nearly seventeen inches at a yard from the ground, and the trees are beginning to take their true form." (Kew Report, 1880, p. 17.)

In the following year Dr. Trimen reported, "The Castilloa, both at Peradeniya and Heneratgoda, produced flowers during the dry weather of April; on examination, however, these were all male. This species is said not to produce seed till eight years old. The finest tree at Heneratgoda has now a stem of 22½ inches in circumference at about a yard from the ground." (Kew Report, 1881, p. 13.)

Dr. Trimen further reported, Oct. 20, 1882, "We have some sturdy little seedlings of Castilloa coming on from our seed. Only three fruits ripened in June, and the fifteen seeds from these were sown at once, and germinated in fifteen days:" (Kew Report, 1882, p. 22.)

It is not necessary to pursue the history of the introduction into the East Indies beyond the appearance of a new seminal generation. It will be sufficient to quote from the Kew Report for 1882, p. 40, the account of the first sample of Caoutchouc obtained from the *Castilloa* under cultivation in the Old World.

"In October 1882, the Director of the Royal Botanical Gardens, Peradeniya, Dr. Trimen, forwarded to Kew a sample of the rubber of *Castilloa elastica* grown in the Experimental Gardens at Heneratgoda, Ceylon. This was sent from Kew in 1876 (*see* Kew Report, 1876, p. 9). The sample was submitted to S. W. Silver, Esq., F.L.S., who very kindly reported upon it:—'On working and drying a portion of this sample, the loss is 12·3 per cent.; it is necessary to use warm water in washing this rubber; it becomes on drying much darker and shorter than Para rubber. It has a bitter taste, which is not removed on washing. The unwashed sample yields 1·9 per cent. ash, the washed sample gives 1·2 per cent. The shortness of this rubbr would restrict its use to some extent where tensile strength or tenacity is required.' It was valued, Dec. 8, 1882, as worth 2*s* 9*d* to 3*s* per pound."

It remains to add that the Darien *Castilloa* has been successfully introduced by plants sent from Kew into Liberia and the Cameroons River on the west coast of Africa, and into Zanzibar and the Mauritius on the east; also into Singapore, Java, Jamaica, and Granada. From Ceylon plants have been sent to Calcutta, Burma, and Madras, and from Singapore to Perak and Queensland.—W. THISELTON DYER